MANURES
AND
FERTILISERS

PRINTED BY W. H. & L. COLLINGRIDGE,
148 & 149, ALDERSGATE STREET,
LONDON, E.C. 1.

MANURES

AND

FERTILISERS

BY

W. DYKE

Incorporating many of the formulæ for
SPECIAL MANURES FOR
GARDEN & GREENHOUSE
of Dr. A. B. Griffiths, Ph.D., and other Experts.

EDITED BY

T. W. SANDERS, F.L.S., F.R.H.S.

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LONDON:
W. H. & L. COLLINGRIDGE "Amateur Gardening" Office
148 & 149, Aldersgate Street, E.C. 1.

AN EDITORIAL FOREWORD.

In these enlightened and progressive times every gardener and allotment holder has been educated to the importance of endeavouring to obtain all that is possible in the way of good crops from the land. Science and practice have taught both the unmistakable fact that, to ensure good crops, they must pay an intelligent attention to the provision of an ample supply of food in the soil, and that food must be of the right character to achieve success.

To enable the cultivators of gardens and allotments, to clearly understand the nature and composition of all kinds of manures and fertilisers, their adaptability to various soils, and the correct methods of application thereto, the present edition of this Handbook is issued for the express purpose of supplying such information in a simple manner, and as free from scientific language as is compatible with lucidity and accuracy. The volume is essentially one for the practical man, and not for the advanced student who is seeking after the scientific side of the subject of manures and fertilisers.

To make the present edition still more helpful and generally informative to the amateur gardener, we have added two additional chapters, one giving the special formulæ for Greenhouse Plants, Annuals, Perennials, Shrubs, Vegetables and Fruit, originally compiled by the late Dr. A. B. Griffiths, and issued in book form many years ago, but now out of print, and additional formulæ by other experts. It is hoped that by including the whole in the present Handbook, the value of the latter, as regards its information on the subject of Manures and Fertilisers will be greatly enhanced.

T. W. S.

London, 1924.

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PART I.

SCIENCE & PRACTICE OF MANURING.

CHAPTER I.

Introductory Remarks.

THE art or practice of farming and gardening is of a very ancient character; the science is of more recent date. Practice is what we do, science tells us why we do it; or, to put it into the words used by one of the best gardeners of this century, "Practice is the gardener's path, and science is a light to the path." A knowledge of manures will be most useful, for at the present time too many work in the dark, and when failure overtakes their efforts, they are unable to account for it, and put it down to blight, or something quite as obscure, when perhaps the cause is due to something over which they have absolute control and could avoid.

An old saying tells us that "knowledge is power," and this is as true to-day as at the time it was written. The cultivator who understands what his crops require, why they need it, and how to supply them with what they want, has acquired information that will be of life-long value. Such knowledge enables the grower for market to obtain larger crops for sale for the same outlay as regards rent and labour; the cottager to secure more produce for consumption in his home from the same area of land; the professional gardener to grow crops that will give his employer more satisfaction; and, last but not least, the amateur to get more satisfaction and pleasure for the time and trouble devoted to the most healthy of all occupations—gardening.

A Knowledge of Manures is Valuable.—The problem of how to make two blades of grass grow where one grew before is always before us. A knowledge of manures and how to use them is one of the most valuable factors in solving this problem. With the gardener it is not so much the doubling of the production as it is adding a little more

weight, bulk, or quality to his crops. Think, Readers, for a moment, what it means to you if by any means over which you have control, you can add a little more weight to each onion, carrot, potato, or any other crop you grow, how it will increase the quantity and quality of your produce; and this same fact applies, no matter whether it be fruit, flowers, or vegetables that interest you most.

Cultivators of every description can produce larger and better crops by a judicious use of concentrated fertilisers in conjunction with dung, than by either used alone. This being so, it is quite as essential for them to be acquainted with the value and use of the different fertilisers in commerce, as it is to know the type of seed to sow, and the proper time to sow it.

As time goes on, and motor traffic becomes more general, there will come a time—and very soon—when horse manure will be difficult to obtain. In one respect this will be a good thing, for gardeners and growers will then be compelled to supplement this shortage by the use of some form of concentrated fertilisers, and the results obtained by the blend will be to their advantage, both as regards quality and quantity of the crops grown.

The most successful cultivators of to-day are those who use dung mainly to obtain a suitable mechanical condition of the soil, and rely afterwards upon suitable, well-balanced fertilisers for feeding purposes. In this way their crops are intensified, and they find that larger yields of better quality produce can be obtained in a much shorter time than if farmyard manure only were used.

Why are Manures Needed?— Plants, like animals, require food. The raw elements of nutrition they obtain partly from the soil and partly from the atmosphere. Plants do not eat in the same way as animals. Their roots, by their ever-radiating and branching nature, penetrate among the particles of soil in all directions, and collect moisture, in which is dissolved soil food. This, when absorbed by the roots, is diffused to every part of a growing plant, the moisture not required being given off as a vapour from the leaves. There is always an upward circulation of moisture in plants, water in which is dissolved those nutritive substances needed by them passing in at the roots, flowing upwards until it finds its way into the leaves, from whence by means of evaporation and transpiration it passes into the atmosphere, leaving the soil food it carried behind, for the use of the plant.

One of the chief objects in applying manures, is to add to the soil some or all of those substances found dissolved in the soil water, so that they may find their way into the plant, and there be used in the construction of the organised food upon which it lives.

The Analysis of Plants.—Chemists by analysing plants can tell what substances are found in them. Thousands of different varieties of plants have been analysed, and it has been found that all of them contain in varying proportions the following substances:—Carbon, hydrogen, oxygen, nitrogen, phosphoric acid, sulphuric acid, potash, lime, magnesia, and iron. There is also a certain amount of silica, chlorine, and soda found, but experiments have taught that neither of these is essential to the growth of a plant, while the same experiments have proved, beyond the shadow of doubt, that no plant will grow and flourish unless it has a supply of the ten substances first named. These are known as the *essential* elements, the other three being called *non-essentials*.

The information obtained by the chemist is most valuable, for it forms a foundation to work upon, and shows what plants take from the soil, and what is needed to be given in manures when crops are fed.

Plant physiologists have carried the work a stage further, and have found that it is possible to produce fully-developed, healthy plants by growing them in pure water or sand, and adding small quantities of chemical substances containing only seven of the ten essential elements of nutrition. When carrying out these tests it was found that if any one of the seven were left out, the plants refused to grow. Very early it was found that there was no need to give carbon, as the leaves obtained this from the atmosphere. The water in which the roots were placed, or that given to the plants grown in sand, is composed of hydrogen and oxygen, and as they had command of so much of these two elements it was unnecessary to consider them.

Facts that Analysis Teaches. — Seeing that the chemist can find out exactly of what material crops are composed, and that physiologists can grow perfectly healthy, fully-developed plants, by feeding them from the seedling stage with seven of the essential elements, let us see what bearing this has upon our subject. Reasoning from these facts, soils and manures ought, when subjected to the same analytical tests, to show that they contain all or some of the elements of plant food. The following table is the partial analysis of 100 lbs. of tomato plant, dung, and fertile soil, and proves that the same

substances are present in both dung and soil as are found in the plant:—

100 lbs. of Tomato Plant contain:	100 lbs. of dung contain:	100 lbs. of fertile soil contain:
2 ozs. of nitrogen.	5 ozs. of nitrogen.	3 ozs. of nitrogen.
4 ozs. of potash.	5 ozs. of potash.	5 ozs. of potash.
1¾ ozs. of phos. acid.	3 ozs. of phos. acid.	1½ ozs. of phos. acid.
2 ozs. of lime.	8 ozs. of lime.	32 ozs. of lime.
¾ oz. of iron.	Traces of iron.	48 ozs. of iron.
½ oz. of magnesia.	Traces of magnesia.	5 ozs. of magnesia.
½ oz. of sulphuric acid.	Traces of sulp. acid.	1½ ozs. sulphuric acid.

A careful consideration of this table shows that the same constituents that are found in the tomato plant, are also present in dung, and in a fertile soil, and taking the three and comparing some of the elements in them, it will be seen that they vary but slightly in the proportions present. It is the more bulky material of the bodies that differ. The great proportion of the 100 lbs. of the tomato plants is carbon and water, and the same fact applies to the dung; but in the case of soils the bulk is due to the presence of humus, sand, and clay. The essential elements are diluted down, as it were, with some material of a non-feeding kind, and this is what makes dung so safe to use. By comparing farmyard manure with some of the concentrated fertilisers, it will be seen that the latter contain such an abundance of food as to make them very injurious to vegetation unless applied only in very small quantities. Examples of these are sulphate of ammonia, bone meal, and sulphate of potash. 100 lbs. of sulphate of ammonia contain 20 lbs. of nitrogen, the same weight of bone meal 4½ lbs. of nitrogen, and 24 lbs. of phosphoric acid, while 100 lbs. of sulphate of potash contains 50 lbs. of potash. The concentrated nature of these fertilisers proves to cultivators the need for great care in using them, for it has been shown that 100 lbs. of tomato growth only requires a few ounces of each of the seven essential elements, and the requirements of this crop is a typical example of all of them.

The Nature of the Soil Food.—From the analysis given, 100 lbs. of a fertile soil does not appear to contain much plant food, but this, when worked out per acre, shows there is sufficient present to last crops for years, if they could only use it; 3½ ozs. of nitrogen in 100 lbs. of soil is equal to 5,625 lbs. per acre, 5 ozs. of potash is equal to 9,370 lbs., and 1½ ozs. of phosphoric acid equal to 2,200 lbs. There is no crop that removes more plant food from the soil than tomatoes. The fol-

lowing table shows how much of the selected constituents are removed from an acre (under glass) during one season :—

	40 Tons of Fruit.	270,000 lbs. of Leaves and Stems.	13,500 lbs. of Root.
Nitrogen	112 lbs.	112 lbs.	12 lbs.
Phosphoric Acid ...	60 lbs.	32 lbs.	3½ lbs.
Potash	212 lbs.	176 lbs.	16 lbs.

The fruit, stems, leaves, and roots require 236 lbs. of nitrogen, 93½ lbs. of phosphoric acid, and 404 lbs. of potash, but from the quantity present in the soil it might be supposed that there would be sufficient to last for at least ten years. In theory it might, but in practice it is found that as much or more plant food must be given in fertilisers as the crops remove, if a continuation of paying results are to be obtained.

The soil may contain abundance of nutriment, but the greater part is in an inert condition, and only becomes very slowly available for the use of crops. There are various causes to account for this, the chief being the different chemical ways in which the plant food is held, the presence of microbe life, and the absence of compounds of weak salts of lime. The organic matter (humus) in the soil contains nitrogen, phosphoric acid, and potash locked up, and it is not until it is attacked by the microbe life that these are liberated. Insoluble compounds of potash and phosphoric acid are also present in the land, and it is with great difficulty that these are made suitable for the use of plants.

The value of lime, either as slaked lime or chalk, helps to bring about conditions suitable for the liberation of much inert material. Tillage is another important factor, and it will be advisable now to point out the advantage of trenching to deepen the soil. If the top foot of an acre contains the quantity of food shown, every inch in depth will greatly increase the quantity.

The following results will show the advantage of tillage. A sample of meadow land was analysed to find out the amount of available food it contained. The soil was found to contain about 45 lbs. of available potash, and 471 lbs. of phosphoric acid in the top foot of an acre. After this land had been cultivated and cropped for five years, manure and fertilisers being added, there was 1,116 lbs. of available potash and 3,774 lbs. of phosphoric acid per acre. The quantity of manure given did not account for the increased quantity of available food because the crop had removed more than was applied.

The Value of Experiments.—Many a grower would save pounds' worth of manures, and others would gain pounds

in value in the produce they raise, if they would carry out a few experiments on the crops they grow. The object of experiments is to find out what manures or fertilisers are best suited for the soil under treatment, the effect of an application of any single element of food, and the quantity needed to give the best results. A detailed system is out of the question for many, on account of the small area of land under cultivation, but large growers, especially those who only produce a few crops, could obtain a great deal of information if a small section was devoted to tests with different fertilisers.

One of the things which everyone can carry out, is to try the effect of a fertiliser containing only one element of food upon some crop. It is not a difficult matter, and in time one becomes so familiar with the appearance of what nitrogen, phosphoric acid, and potash will do, as to be able to say by looking at a crop which substance would suit it best.

Another very important thing, which every cultivator can do, is to try the effect of an application of some mixed fertiliser. Various mixtures will be given in the chapters on application for different crops. Let one of these be used upon one or two rows of vegetables, or given to a few fruit trees, leaving some not treated, and in many cases even the most prejudiced person will have to admit that the beneficial results will more than compensate for the cost.

CHAPTER II.

Structure and Function of Plant Tissues.

It is necessary in a work of this kind to give a brief outline of the structure and functions of the different parts of plants, so as to enable growers to understand something of the way the moisture and soil food enters the roots, and what it does after it gets there.

The whole structure—roots, stems, leaves, and flowers—of a plant is composed of an aggregation of different kinds of cells. These cells in the very early stages of their development are very similar in shape to a honeycomb (see Fig. 1), but they are very small, and can only be seen by aid of a microscope. As they grow older they vary in shape and size, the alterations they undergo making them suitable for the formation of the various kinds of tissues.

The cells of plants play the most important part in their development of growth. By division one cell becomes two, and these in their turn again divide and form four, and it is by this constantly repeating division and subsequent enlargement that causes the well-known phenomena of growth.

What a Cell is Like.—A fully-developed cell consists of three parts. First of all there is an outside membrane, consisting of a substance like cotton-wool, called *cellulose*, this being known as the cell wall (Fig. 3). Secondly, inside the cell wall there is a layer of a gelatinous substance similar to the white of an egg; this is known as the *protoplasm* (Figs. 1, 2, and 3), and embedded in this is a more or less round, denser mass, called the *nucleus* (Figs. 1, 2, and 3). Thirdly, there are one or more large cavities inside the protoplasm called *vacuoles* (Figs. 2 and 3), and these are filled with cell sap.

The protoplasm is the substance endowed with life, and carries on all the vital functions in the plant. When the cells are young (Fig. 1), there are no vacuoles, the protoplasm fills the whole cavity formed by the cell wall; but as they increase in size, owing to internal pressure, vacuoles begin to appear, and these increase in size until they all merge into one, the protoplasm at this time forming a continuous lining surrounding every part of the inside of the cell wall (Fig. 3).

As the cells grow older some of them undergo many changes. Fresh cellulose is deposited on the inside of the existing cell walls, causing a thickening and strengthening

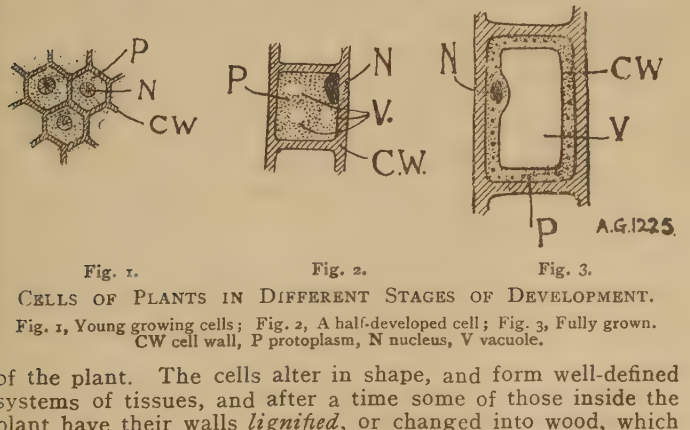

Fig. 1. Fig. 2. Fig. 3.

CELLS OF PLANTS IN DIFFERENT STAGES OF DEVELOPMENT.

Fig. 1, Young growing cells; Fig. 2, A half-developed cell; Fig. 3, Fully grown. CW cell wall, P protoplasm, N nucleus, V vacuole.

of the plant. The cells alter in shape, and form well-defined systems of tissues, and after a time some of those inside the plant have their walls *lignified*, or changed into wood, which

gives greater turgidity and strength. The cells on the outside (epidermis) of the older parts of plants lose their contents, and become filled with water or air, and the cellulose walls change into *cutose*, a substance very impervious to water. This prevents the escaping of moisture from the tissues, and forms a protective covering.

Functions of Roots.—The functions of roots are of a two-fold nature—firstly, to fix and hold plants in position; and, secondly, to absorb moisture in which is dissolved all the elements of soil food. A very large quantity of water is taken up from the soil by the roots, for the soil food only dissolves out in the minutest quantities, and after passing through the plant much of the moisture is given off (transpired) into the atmosphere, leaving the nutriment it carried behind for the use of the plant.

It has been found that an ordinary crop will give off from its foliage from 300 to 450 lbs. of water for every pound of solid food formed; thus the importance of a good supply of water in the land, and of sufficient root surface to absorb the same, is shown.

The root system of plants varies very much in different kinds of crops. Some, like lettuce and cabbage, are very shallow but very fibrous-rooting; while others, like peas and beans, penetrate deeply into the soil, but are not so branched. Parsnips, carrots, turnips, etc., form one long tap or bulbous root, from the surface of which numerous feeders and root-hairs spring. Keeping this fact in view, suggests where in the soil the nutriment ought to be, and is a guide to the grower.

Root Absorption.—If a bladder be partly filled with water in which some ordinary sugar has been dissolved and held up by the hand, the water will not leak or run out; but if the neck of the bladder be tied tightly, and the bladder be immersed in a bucket of clear water, it will be found that the water will go from the bucket into the bladder, and that some of the sugar water will pass into the clean water. The clear water will go in more rapidly than the sugar water will come out, and so after a time the bladder will become filled and turgid, providing sufficient sugar be used. If saltpetre or common salt be used instead of sugar the same action takes place. The diffusion or passage of liquids or solutions through a membrane like the bladder, in which there are no visible openings, is termed *osmosis*. Each living cell of a plant is similar to a very tiny bladder, the cellulose wall forming a closed membrane, and the cell sap forming an attractive liquid for the soil water; but there is a difference between a living

cell and a bladder, for the protoplasmic lining prevents its escape back again into the soil. The absorption of soil water by the outer cells dilutes or weakens the contents of the absorbing cell, and the next inner ones, now having stronger attractive power, absorb the water, etc., this process going on from cell to cell, causing a continual flow of moisture upwards. Water is constantly being transpired and evaporated from the leaves, and this helps to keep the current moving. The active, absorbing cells on the roots, when gorged with water, set up pressure, and water is by this means forced up the open pitted and spiral vessels.

Root Hairs are the Principal Absorbers.—If a few mustard seeds are sown on a piece of flannel, and kept moist, germination soon takes place. When the primary root (radicle) has grown about an inch in length, if it be examined it will be found covered with a mass of tiny root hairs (Fig. 4). These do not extend quite to the tip of the roots. They are not young roots as many suppose, but are outgrowths of the outside cells on the surface of the roots. All actively growing roots are always covered with root hairs.

These and the newly-formed cell on the surface surrounding them, immediately behind the root tips, are the organs most actively engaged in absorbing soil moisture and food. They (the root hairs) come into very close contact with the particles of soil, and offer a wider surface for absorption than would the cells themselves. The older roots absorb but very

Fig. 4. Seedling Mustard Plant furnished with root hairs.

little. When seedling, or even older, plants are transplanted, most of the tiny root hairs are broken off, and the plants will droop or flag until fresh ones are formed. They are very delicate, and an overdose of any strong fertiliser will soon destroy them.

It will be seen by looking at Fig. 5 that the true roots grow from internal tissue, and Fig. 6 shows the root hairs are long hollow tubes formed by the outgrowth of the surface cells.

Influence of a Good Root System.—Plants have only one way of obtaining water and soil food, and that is by means of their roots. As the larger roots are of very little use for this purpose, it shows how important it is to have plenty of a healthy, growing, fibrous nature, so that growth and development of the tops may not suffer for want of sufficient moisture and nutriment. The whole art of successful feeding is to use a soil mixture that will induce good root action, and when this is obtained, feed carefully, giving only very small quantities at a time, as the plants require the food, and, unless only one element of food is needed, always use a well-balanced fertiliser.

It is found in practice that soil of hard, gritty texture induces the best root development, and one containing too much dung, and insufficient supply of lime, or soluble, con-

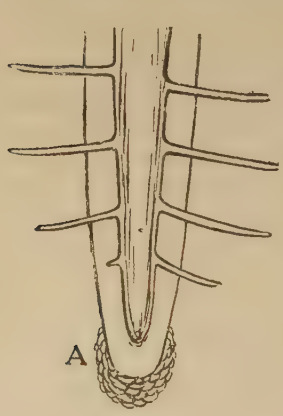

Fig. 5.

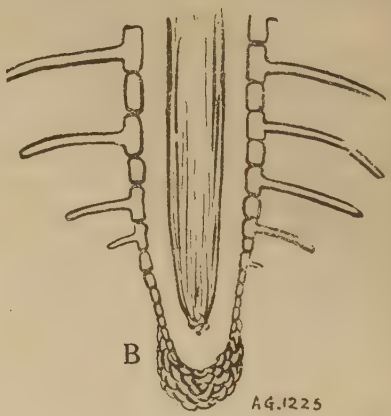

Fig. 6.

A Root tip showing position whence true root fibres spring. B Root tip showing root hairs are outgrowths (hollow tubes) of the epidermal cells.

centrated fertilisers, a very poor one. Naturally plants differ very much in what kind of soil will suit them best; but, broadly speaking, it is much better to have the soil on the poor side rather than too rich, providing sufficient nutriment be afterwards applied, and when fertilisers are used in soil mixtures, choose those of a slow-acting character.

Structure of Stems.—If a thin section of a stem of

A WELL-FRUITED TREE OF COX'S ORANGE PIPPIN APPLE.

The development of so heavy a crop would be greatly assisted by the application of one of the fertilisers described on pp. 77 and 118.

A SPLENDID CROP OF MELONS.

See pp. 85 and 119 for special fertilisers for feeding Melons.

any herbaceous plant be examined, the section being taken in a longitudinal direction, it will present features similar to that shown in Fig. 7. On the left-hand side a layer of empty cells (E') may be seen, forming the epidermis. These, when the stem is any age, have cuticularised or corky walls, and by means of this protective covering the evaporation of the moisture from the adjacent cells cannot take place. The next layer of cells is the endodermis (E''), and these are filled with starch grains. The bast fibres come next, and give strength and toughness to the stem, and next to these three sieve tubes (S T) are shown. When food material is made in the leaves or other parts of the plant, it is transferred through these tubes from one part of the plant to another. Next to the sieve tubes a mass of small cells (C) are shown. These form the cambium, and are the only cells capable of dividing and multiplying; and it is by the development of this layer that new permanent cells are formed, causing the increased growth of the stem.

When budding roses the operator cuts through the bark until he reaches the cambium layer. The inside of a pre-

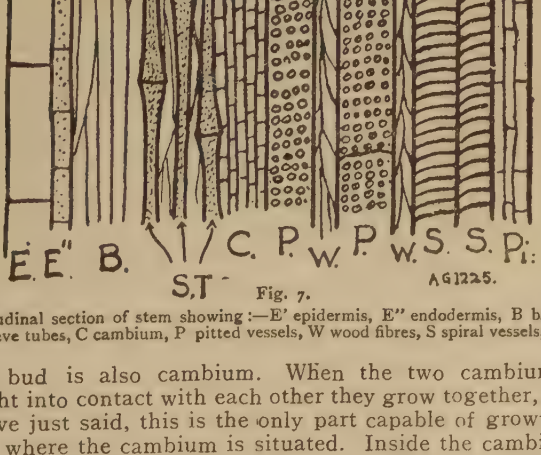

Fig. 7.

Longitudinal section of stem showing :—E' epidermis, E" endodermis, B bast fibres S.T sieve tubes, C cambium, P pitted vessels, W wood fibres, S spiral vessels, Pi pith.

pared bud is also cambium. When the two cambiums are brought into contact with each other they grow together, for, as we have just said, this is the only part capable of growth, and shows where the cambium is situated. Inside the cambium we have several pitted and spiral vessels, which are really long hollow tubes, and these are surrounded by long wood cells.

When water is absorbed by the root hairs, it is through these vessels and wood cells that it passes from the roots to every part of the plant, most of it, of course, passing upwards through them until it reaches the leaves.

One thing our readers should notice, and that is the position of the cambium. On one side the organised fully-formed food passes, on the other the water and raw unorganised soil food, the first in a downward direction, the other upwards. As growth in the cambium takes place, and new tissues are formed, food for this development is required, and this it can obtain from the sieve tubes on the one side; and, on the other hand, if moisture, or anything the moisture contains, is needed, that also can be easily absorbed. The function of stems is to hold the branches, which, in their turn, carry the leaves, in such a position as to enable the foliage to carry out its important work, and also to form a medium through which water and soil food may pass from the roots to the leaves, and the manufactured food may pass to all parts where required.

Structure of Leaves.—The leaves of plants are very important organs. Usually they present more or less flat surfaces to view, but in some cases (onions) they are round. No matter what the shape, their organisation is the same—i.e., the major portion is made up of numerous little cells through which a whole network of veins ramify. The little cells are really tiny workshops in which plant food is made, and the veins are a system of channels through which water and other material

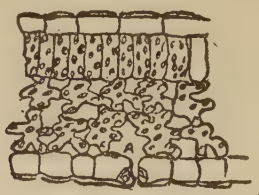

Fig. 8. Transverse Section of a Leaf.

is brought up from the roots, and the manufactured food, when made, is carried to all parts of the plants.

It will be seen by looking at Fig. 8, which is a transverse section through a leaf, that there is a flat layer of cells on the upper and under surfaces, forming an epidermis. On the under surface one of the tiny mouths (stomata) is shown, and it will be noticed how the opening connects direct with intercellular spaces in the leaf. There are thousands of stomata

on every leaf, and these play a very important part in the leaf's work. They form tiny openings through which the gases from the atmosphere can gain access to the inside of the leaf, and the water brought up by the roots, and not required, can be given off.

Functions of Leaves.—On looking at Fig. 8, it will be seen that each of the cells contain a number of small, dark, roundish bodies. They lie in the protoplasm, and cell sap saturates the whole. Leaves appear to the unaided eye to be of a uniform green, when that colour predominates, but this is found to be a mistake when investigation is made by aid of a microscope. The little dark bodies shown in the cells in Fig. 8 are the only green parts, and they are called *chloroplastids*, because they are plastids stained green by chlorophyll.

The carbonic gas in the atmosphere enters the leaf through the stomata, and penetrates through the intercellular spaces to every part of a leaf, and, of course, comes into close contact with the chloroplastids. The water brought up from the roots also permeates all the cells. Under the action of sunlight the acid and water are broken up; some parts of them are used by the chloroplasts to form sugar, the others pass from the leaf into the atmosphere in the form of a gas. In strong sunlight the formation of sugar goes on so fast that it cannot be carried away fast enough, and starch grains are formed in the leaf from the sugar. The conversion of the carbonic acid gas and water into sugar is known as *assimilation*. Now assimilation cannot take place unless the leaves contain chlorophyll, and are exposed to sunlight, and it is also found that potash must also be present in the cells during starch formation.

Everyone knows how slowly plants with variegated foliage grow compared with green ones of the same variety. In the first case only some of the cells contain chloroplastids; assimilation is, therefore, not so great, and consequently growth is slower. Some plants, like the copper beech, red cabbage, beet, etc., have various coloured leaves. Chlorophyll is also present in every case, but its presence is hidden from view by the coloured cell sap.

Importance of Good Foliage.—It has been shown that all the food upon which plants live is formed in the leaves or parts coloured green by chlorophyll, and this cannot be made unless the foliage be exposed to sunlight. This being so, it proves to all cultivators the necessity of having good, well-developed foliage exposed to the light, and the disadvantage of overcrowding. Manures and fertilisers are of no

value to plants unless the foliage can, without hindrance, do its proper work. Given good roots and well-developed foliage, crops will produce maximum results, and a suitable system of feeding will be of the greatest assistance in developing them.

CHAPTER III.

The Food of Plants.

ALL plants require food for life, growth, and development, and unless they can obtain what they require, a starved, stunted crop is all that can be obtained. The raw elements of food are taken partly from the soil and partly from the atmosphere, and these are united and blended together inside the plant to form the *organised* food which is used for its nutrition.

The principal object in supplying manures to soils is to supply the raw elements for the roots to absorb, for this is the only way it is possible to feed crops. It is necessary, therefore, to find out what substances plants require, why they need them, and the best form in which they may be applied.

Ten Elements are Necessary.—A living, healthy, growing plant—no matter what kind—requires ten elementary substances. These are as follows: Hydrogen, oxygen, carbon, nitrogen, sulphur, phosphorus, potash, lime, magnesia, and iron. There are a few other elements in plants like soda, chlorine, and silica; but it has been proved by most carefully conducted experiments that these have no direct feeding value, and that the first ten named are those essential in the building up of plants.

As we proceed it will be shown that when plants are fed it is not necessary to supply all of the ten elements, for nature supplies some of them in such large quantities as to make it useless to give more. The elements that are usually deficient in soils and must be given are nitrogen, potash, and phosphates. In many cases lime also is necessary. Occasionally it is found advisable to apply magnesia, for this enters largely into the composition of some plants, and has a marked influence on their development. There are also a few soils which do not contain sufficient iron in a soluble form. To such it is necessary that a salt of iron be applied.

Hydrogen and Oxygen.—Hydrogen is a colourless

invisible gas, possessing neither taste nor smell, and is the lightest substance known.

Oxygen is also a colourless invisible gas, possessing neither taste nor smell, and weighs nearly sixteen times heavier than the same bulk of hydrogen.

When hydrogen and oxygen unite together they form the very common substance known as *water*, and this is one of the most essential compounds in plants, for without it no plant could exist. Timber felled in the dryest time contains from 40 to 60 per cent., and succulent vegetation like lettuce, spinach, begonias, and gloxinias, contain quite 95 per cent. of water. It not only forms the greater part of all vegetation, but also has many functions to perform in the life of plants. It dissolves small quantities of certain substances from the soil, and these and the water pass through the roots into the plant, and ultimately into the leaves. The water not required then passes from the leaves into the air, either by transpiration or evaporation, leaving the raw food material it brought from the soil in the plant, to be worked up into more highly constructive food. By this means an upward circulation of liquid is obtained, and the leaves kept cool.

The Use of Water.—It is a mistake to think that because there is 95 lbs. of water in 100 lbs. of succulent vegetation, that it exists in their tissues as such. When it enters the roots it becomes a part of the plant, exactly the same as any other substance taken up, and is quite as important as nitrogen, potash, or phosphates.

Water forms the greater part of the cell sap, and when combined with carbon the two together make material from which all the tissues of a plant are constructed. It also forms a constituent part of all the other vegetable products formed in and by the plant like starch, sugar, inulin, vegetable oils, amides, proteids, etc. Water not only forms a most important part of all living vegetation, but also acts as a substance in which the soil food may dissolve, and by this means forms a carrier, taking into the plants such food material as required.

Carbon. — When a heap of wood is burnt and the air excluded, a black porous substance called *charcoal* is formed. Charcoal is nearly pure carbon, and next to water forms the more bulky material of plants. If we set fire to a heap of charcoal and allow the air free access to it, the charcoal will burn, the carbon unites with the oxygen gas of the atmosphere, forming an invisible gas called *carbonic acid gas*, which passes into the air.

On an average every 10,000 volumes of the atmosphere contains four volumes of carbonic acid gas, and this is the source from whence plants obtain all the carbon they need. Two things are brought before us from these facts—firstly, the change of the solid charcoal into an invisible gas, and the conversion of this invisible back again into solid, visible plants.

The Use of Carbon.—As we have already shown, a plant is composed principally of water, and yet it is more or less solid. It is interesting to note that the solidity of all vegetation is due to the presence of carbon. Ordinary loaf sugar is a very hard, brittle substance having a vegetable origin, and yet it is composed entirely of water and carbon chemically united. A pound of sugar contains 9¼ ozs. of water and 6¾ ozs. of carbon. The wood, bark, and roots of plants are formed of material very similar to sugar in composition, and from this it can be seen how the carbon gives solidity to vegetation.

How Plants Obtain Carbon.—The leaves of plants are formed of thin plates of cells, and the undersides are covered with tiny pores called stomata. The gases of the atmosphere pass through the latter into the loose, inter-cellular spaces inside the leaves, and are absorbed by the adjoining cells. Water coming up from the roots passes down the veins of the leaves into the cells around the intercellular spaces, and so air and water are brought into contact with each other. Under the action of sunlight a very important chemical change takes place in these cells. The protoplasm has the power to break up the carbonic acid gas obtained from the air, and the water obtained from the roots, rearranging some of the parts so as to form an *organised* food, rejecting others, which are allowed to escape into the air. The importance of this first organised food cannot be overestimated, for the whole life and development of crops depend upon its formation, it being from this substance that every part of a living plant is built up.

We can perhaps show better how the changes take place by means of a simple diagram, but first of all the composition of water and the carbonic gas must be understood. Water is composed of 2 parts of hydrogen and 1 part of oxygen. Carbonic acid gas of 2 parts of oxygen and 1 part of carbon. In chemistry symbols are used instead of words, and water is represented as H-O-H, and carbonic acid gas O-C-O. The change taking place in the leaves is as follows:—

BEFORE THE CHANGE.

Water.	Carbonic acid gas.
H-O-H.	O-C-O.

After the Change.

First organised food.	Oxygen gas liberated.
H-C-O.	O-O.

It will be seen that two parts of oxygen (O-O) are liberated, and escape into the air during the change. One of these comes from the water, the other from the carbonic acid gas. The two parts of hydrogen then unite with the carbon and remaining part of oxygen, forming a substance in which all are chemically united. By an aggregation of this first organised food starch and sugar are formed, which form the very life food of crops.

To do work of any kind energy is needed. This is obtained from the sun's rays by the green colouring matter (chlorophyll) in the leaves.

Nitrogen.—This is a very important substance found in every growing plant. Water forms the greater part of all vegetation, and next in quantity comes carbon, but nitrogen is the ingredient which gives vitality to all plants. Every substance endowed with the power of life contains this element, but it is always found combined with water and carbon. The protoplasm in the cells, in some mysterious manner, unites the nitrogen with the products formed from the first organised food, joining them together, and making them capable of continuing the same life work of building up more living matter, and so carrying out all the vital work connected with growth and development.

Nitrogen is an invisible gas, possessing neither taste nor smell, and as such forms four-fifths of the atmosphere. In this condition it is of no direct feeding value to plants, for with the exception of the pea and bean family (leguminosœ), all the nitrogen they need is absorbed from the soil in a combined form. The leguminous group cannot themselves utilise this free nitrogen as food. Certain bacteria are present in the soil and in the little wart-like knots upon their roots, and it is these that change the atmospheric nitrogen into such a condition as to be of use to the plants.

Three Forms of Nitrogen.—We have just said that plants can only use combined nitrogen as food, but there are many kinds of nitrogen in a combined state which do not form the food they need. Plants, so far as we know, absorb the nitrogen from the soil, either as nitrate of lime, potash, or soda, or as ammonium salts. There is a certain amount of evidence to show that there may be other forms also taken up by them from the soil.

There are three principal conditions in which the combined nitrogen exists in soils, and also in the various fertilisers, and

a consideration of these is essential if we wish to understand how plants obtain this element of food. The three forms are: *organic*, examples of which are hoof and horn, dried blood, and fish meal; *ammoniacal*, present in sulphate of ammonia, and soot; and *nitric*, such as is found in nitrate of soda, potash, or lime. Decomposed farmyard manure contains both organic and ammoniacal nitrogen, and all three forms are present in a few of the best guanos.

When any kind of organic nitrogen is applied to crops, it has to undergo several changes before they can use it. The organic form is first of all changed into ammonia by the action of certain microbes, the ammonia is then converted into nitrous and finally into nitric acid by the action of two other kinds of soil microbes. When the nitric acid is formed, it unites with lime in the soil, forming nitrate of lime, and this is the condition in which nitrogen is taken up from the soil by crops.

When fertilisers containing ammonia are applied to crops, the ammonia has to be changed into nitric acid exactly the same as the organic nitrogen; but as one set of changes is already completed, i.e., from the organic to the ammonia form, the effect of the application of such material is quicker than when an organic form be given. All the nitrates are soluble in water, and all of them may be looked upon as direct sources of nitrogen food. They are, therefore, the most quickly acting substances that can be used, and when applied plants can utilise them at once.

How to Tell when Nitrogen is Needed.—Nitrogen is the substance most actively engaged in the building up of a new growth—such as stems, shoots, and leaves. If plants lack vigour, and have a starved, stunted appearance, with pale green foliage, it shows at once that they require nitrogen. When they are in this condition a small quantity of a quickly-acting fertiliser should be given, following up in a few days with a slower form. If nitrate of soda or potash be given, three days afterwards the foliage should begin to change to a dark green, and if a little dried blood or sulphate of ammonia be then applied, growth should start away, and a complete change in the character of the plant be noticed. Plants may be kept from getting into a starved condition if small quantities of any nitrogenous fertiliser be given occasionally during their growing season.

Leguminous Plants and Nitrogen.—If a pea, bean, clover, lupin, or any plant of the pod-bearers be pulled up and examined, the roots will be found covered with small warts

or nodules. These are caused by tiny colonies of bacteria, which fix themselves to the host plant, and they, in conjunction with other kinds in the soil, have the power to convert the nitrogen gas of the atmosphere into a form which may be used as food by the plant to which they are attached, the host plant supplying them with the food they need for their development. The pod-bearers then have a store of nitrogen they may utilise independent of the nitrates, but it does not do for growers to leave the work of supplying nitrogen entirely to the microbes. If they wish to have soft, succulent peas or beans, or fine flowers, they must apply nitrogenous food, the same as they would if there were no help being given.

Sulphur.—Sulphur is a substance too well known to need any description from us. It is never found in a free state in soils, nor in plants. It unites with other substances and forms sulphates, and it is from these sources that plants obtain all the sulphur they need. In practice we never apply sulphur in any form for the purpose of food. Crops require only very small quantities, and there is an abundance in all kinds of land.

Phosphorus.—Phosphorus is a very important element of plant food, but is never found in a free state in nature. It is always present combined with other elements, forming phosphates. The most abundant form is phosphate of lime, and when phosphates are bought as a fertiliser this is the usual condition in which they are purchased. There are a few very special things, like phosphate of potash, phosphate of magnesia, and ammonium phosphate, which may be bought for plant feeding. These are very good for the purpose, and give excellent results, but they are too expensive, except for special purposes.

What Phosphates Do.—No satisfactory proof has ever yet been brought forward to show what phosphates actually do in plants, but it is known that the effect on crops of an application of a fertiliser containing them helps in the production of flowers, fruit, and seeds, and prevents the excessive absorption of nitrogen from the soil. If a growing crop of lettuce be watered occasionally with nitrogen in the form of nitrate of soda, large plants with tender leaves will be produced; if, on the other hand, no nitrogen be given, but a substance like superphosphate be used, which contains only phosphates, very small, tough leaves only will be produced, and the plants will run to seed. To give another typical example, a tomato plant fed with nitrate of soda produces plenty of stem and leaves and very little fruit, but when superphosphate is given instead of the nitrate, plenty of fruit is formed, but

very little foliage or growth. The same quantity of nitrate of soda, in conjunction with superphosphate, would produce good solid plants which would fruit well.

We have seen fruit trees where large quantities of flowers are formed each year, but the crop never comes to anything because there is no vigour in the trees; and, on the other hand, there are plenty of trees which make a lot of vigorous growth each season, but never produce a satisfactory crop of fruit. The former show clearly that they want nitrogen applied in some form; the latter show there is too much nitrogen and not sufficient phosphates.

Potash.—Potash is a substance formed by the chemical union of the metal known as potassium with oxygen gas. Neither potash nor potassium are ever found in nature in an uncombined state. They may be bought from a chemist, but in the condition named they would be useless as food for plants; in fact, they would kill any plant to which they were applied.

What Potash Does.—Potash in a combined form is a very important plant food. It is found in every part of a plant, especially in the young growth and leaves. The work it does is to help in the formation of the first organised food produced by plants. We have shown that under the action of sunlight, water and carbon are changed and blended together to make a substance which ultimately forms every part of a plant. This blending process is called *assimilation*. Now it has been proved by experiments that no assimilation can take place unless potash be present, and consequently without assimilation there can be no growth.

If we wish our crops to do well, to mature early, and to give satisfactory results, we see how important it is that they have sufficient of this essential food. This is particularly noticeable in such things as potatoes, beets, onions, artichokes, and fruit, which produce starch, sugar, or inulin, and store it up in the tubers, bulbs, or fruit.

Potash may be had in a combined condition in many different forms. Wood ashes contain variable quantities of carbonate of potash; there is also the commercial carbonate of potash, too expensive for ordinary use; kainit, which contains 25 per cent. of sulphate of potash; sulphate of potash; muriate of potash; nitrate of potash, and phosphate of potash. The form given to vegetables, and outside fruit and flowers, is usually kainit; but for special crops and plants under glass, one of the other kinds should be used.

Lime.—Lime is a substance which has very important functions to perfom in the growth of vegetation. Lime is

formed by the union of the metal calcium and oxygen gas, but it is never found in nature in a free state. The most abundant forms in which lime exists are the great masses of limestone rocks, marble, and the deep beds of chalk. These are all in the form of carbonate of lime, i.e., lime in combination with carbonic acid. There are also lesser quantities of lime found on the earth in the form of sulphate, silicate, and phosphate of lime.

Lime has several duties to perform in plant nutrition, the principal being that of a carrier, and when inside the plant to act as a disinfectant. Lime combines with nitric and phosphoric acid, forming nitrate and phosphate of lime—both of which are taken up from the soil as plant food. The lime, when united with these, carries them into the plant, and when inside the nitrogen and phosphoric acid are used up in the formation of new growth, and the lime is free to combine again. During growth there are certain acids formed in plants which, unless neutralised or removed, would kill them, the principal one being oxalic acid. The lime unites with the oxalic acid and forms oxalate of lime, and crystals of this may be found embedded in the cell walls of many plants.

Magnesia.—Magnesia is formed by the union of the metal magnesium and oxygen, but it is never found in a free state in nature. The principal forms present in soils are silicate and sulphate, the former predominating.

Magnesia has very important work to do in the nutrition of plants. It appears, so far as is known, to work in conjunction with nitrogen, in the formation of the living substance called protoplasm, without which no plant life would be possible. It is found in fairly large quantities in the ash of many plants. The ash of the chrysanthemum contains 10 per cent.; the rose, 7 per cent.; raspberries, 11 per cent.; and asparagus, 13 per cent. These are typical examples.

Soils, as a rule, contain sufficient magnesia for the requirements of crops, but there are occasions when it is necessary to apply it in some form to them. When plants are known to be receiving plenty of food, and the colour of the foliage is of a pale yellow nature, it is an almost sure sign that magnesia is wanted. When such a condition of the foliage is noticed, it is an easy matter to get a penny box of carbonate of magnesia from the chemist, and put this in three gallons of water, and water the plants.

Iron.—Iron is a very important substance to plants. The green colouring matter (chlorophyll) in the leaves of plants is due to the presence of a small quantity of iron. We pointed

out earlier in this chapter that the energy necessary for a plant to do its work was taken from the sun's rays. The green colouring matter in the leaves is the substance engaged in abstracting the energy.

Iron is found in large quantities in most soils, and is present chiefly in the form of iron oxide or rust. There are some few soils in which iron is not present in sufficient quantities, or the form is not in a suitable condition. When such is the case, the leaves of plants will be pale in colour, but this so seldom happens that we should advise growers to try the effect of giving nitrogen and magnesia separately, before applying iron, to see if the paleness is not due to a lack of one or both of these elements.

What the Elements of Plant Food Do.—To sum up briefly, it has been shown that some of the elements of water and carbon unite to form the first organised food of plants. This cannot be formed if potash is not present. The energy necessary to carry on the work is obtained from the sun, and iron is the substance which gives the green colour to leaves to enable them to extract the energy. Nitrogen is the substance which gives life, and magnesia helps in the formation of this living matter. Sulphur and phosphorus enter into the composition of all the more highly-constructed products of the living protoplasms, and the latter substance has a great influence in the production of flowers, fruits, and seeds. Lime carries into the plant certain substances which plants need, and unites with bye-products formed in and by them, making harmful substances harmless.

Plant Food is Absorbed as Salts.—The different ingredients of plant food do not pass into plants separately. They are absorbed from the soil in the form of salts. Sulphur, phosphorus, and nitrogen unite with oxygen and hydrogen to form *acids*, like sulphuric, phosphoric, and nitric acid. Potash, lime, magnesia, and iron oxide are bodies known as *bases*. When an acid and a base are brought into contact with each other, they chemically unite and form a *salt*. To give examples of this we may say that when sulphuric acid is brought into contact with either of the bases named, a salt called sulphate of potash, lime, magnesia, or iron, would be formed. Phosphoric or nitric acid would unite with the bases in a similar manner, forming phosphates or nitrates of potash, lime, magnesia, or iron, according to the material used.

There is one substance, viz., nitrogen, which may act both ways. When chemically combined with oxygen and hydrogen it forms nitric acid, but when combined with hydro-

gen only it forms a base called ammonia. It is well known that acids will combine with ammonia, for sulphate of ammonia is the product of such a union.

So far as is known, every particle of the food of plants is absorbed from the soil of a salt, and manures change into salts before they are taken up. Of course, many of the fertilisers are bought in this form, and this is the reason they produce quick results, for they are not dependent upon any alteration or change before becoming available.

Plant Food Must be Soluble. — All plant food before it is able to pass into the roots of plants, must be in a soluble condition, i.e., it must dissolve in the soil water. The roots cannot take up solid matter, be the particles never so minute. If a small quantity of nitrate of soda or sulphate of potash be placed in a glass of water, it will dissolve—disappear, and in that condition could pass directly into the roots; but if, on the other hand, a few pieces of bone were put into the water they would remain unchanged, for they are not soluble, and hence for immediate action are useless.

Water will dissolve many substances, soil water will dissolve still more, and the acids exuded by the tips of the roots will dissolve substances of which neither of the others are capable of doing.

CHAPTER IV.

Soils and their Use.

ALL soils, except those of a peaty nature, have been formed from the primary rocks; in fact, their bulk is nothing more or less than powdery, pulverised rock fragments. The stones are more or less rounded pieces of such material, gradually being reduced in size by friction, and the natural disintegrating agents like water, air, and frost.

In some parts of the country the soil has been formed from the rocks upon which it is found lying. In other parts it has been transported, perhaps hundreds of miles, by water, and there are plenty of instances, near the coast, where the soil consists chiefly of sand driven inland from the coast during stormy weather.

Ages ago, when the primary rocks were broken down by the weathering agents, the material was carried away by

water, and formed sedimentary rocks in the bed of the ocean. These in turn became dry land, and the surface was again attacked and pulverised, and so we have soils varying very much in character and composition in different parts of the country. As a general rule, soils in the West of England are the oldest, and those near London and the South-East are the newest, the soil of the Midlands being of an intermediate character.

The Constituents Forming Soils. — The constituents forming soils may be divided into two distinct parts: (1) the *inorganic*, which forms the bulk, consisting of pulverised, rotten rock; and (2) the *organic*, which is formed of the decaying remains of vegetable and animal matter. The former cannot be destroyed by fire, and is said to be incombustible, but the latter will burn and disappear into the air in the form of various gases, and is therefore combustible.

All soils are composed, in varying proportions, of two or more of the following ingredients—stones, sand, clay, chalk, and humus, the first four forming the incombustible, the last the combustible. Each of these bodies possesses properties of its own, and influence the character of the soil, as a whole, according to the amount present. Each of these substances must be studied separately, and then it will be better understood what effect they produce when mixed, and enables growers to understand what material to use to improve them, for it is only very few soils that contain the material in the proper proportion to form an ideal soil.

Stones.—The stones in soils are more or less rounded pieces of hard rock, which are constantly being reduced in size by friction and by the various weathering agents. The majority of the stones in English soil are formed of silica. Typical examples of these are the quartzite pebbles of the Midlands, and the flints in the soil near London and the surrounding counties. When these stones are broken down they form sand, a fact which may be proved any day by observing what takes place on our roads when either of these kinds of stone are put upon them. In other parts of the country, more or less rugged stones are found, which consist of solid pieces of shale, slate, and granite. These form, when broken down, soils of a clayey nature, and will yield a certain amount of mineral food for plants.

Too many stones in a soil are harmful, for they make the soil too open and free, and such do not retain sufficient water or food for the crops. They also make the soil difficult to work. The larger stones should be picked off the land, and

if material be added of a binding nature stony soils may be greatly improved. A certain proportion of stones will do good, for they retard evaporation, and when the soil is stiff and heavy they help to keep it open. Unfortunately the heavy soils, as a rule, contain the least number of stones, and those of a light sandy nature the most.

Sand.—Sand is chemically nearly pure silica, and consequently there is nothing of any feeding value in it. It is from the impurities in land of a sandy nature that plants get their food.

Sand forms the bulk of most cultivated land, and when not too abundant is a most useful substance, for it forms material of a loose, friable, porous nature, and makes soils warm and dry. Given sufficient water and plant food, very good crops can be obtained from such soils, providing there is some binding material also present. Very sandy soils are not suitable for the production of heavy crops, unless means are taken to improve them, the reason being that they have very little retaining power for water or plant food. If these faults are corrected, satisfactory results will follow.

Clay.—Clay and clayey soils are exactly the reverse to those of a sandy nature. They are formed of material which is plastic, sticky, and close when wet, and which forms hard lumps of stuff, very difficult to work when dry. Water and air percolate through them with great difficulty, and consequently they are wet and cold.

Pure clay is composed of water, silica, and alumina chemically united, and is called *hydrated silicate of alumina.* Ordinary garden clays are made up of a mixture of fine sand, tiny sandy particles of a substance called silicate of alumina, and a certain proportion of pure clay. It takes very little of this pure clay to make a soil sticky, for the most tenacious do not contain more than 2½ per cent. of it.

Clay, like sand, is composed of material which does not contain a particle of plant food, but a clayey soil always contains impurities, and these supply plants with what they need. They may be improved by proper treatment, and then form a useful class of soils, which will produce heavy crops of produce, but not so early as those of a sandy nature.

Chalk (Carbonate of Lime).—All soils contain a certain proportion of combined lime, some of which is in the form of silicate of lime, a variety of very little use, the remainder being present as chalk. The amount varies very considerably in different parts of the country. There are plenty of soils which do not contain anything like enough,

others where the amount is in about the right proportion, and a third series which contain too much. Those which contain an insufficient quantity are usually old, rich, garden soils, those of a peaty, fenny, or boggy nature, stiff clays, and some sandy soils. The soils which contain sufficient are those formed near chalk and limestone districts, and soil of a marly nature is always well supplied. The lands which contain too much are those formed of the calcareous material derived from the chalk and limestone rocks.

Humus.—Humus is formed by the decomposition of animal and vegetable matter, chiefly the latter, and varies in colour from a light brown, as found in peat, to almost black, as present in bogs. Typical examples of humus are the substance known as leaf-mould, old hot-bed manure, and the peat used for potting purposes.

Sand, clay, and chalk are the earthy or mineral parts of a soil, and by themselves are incapable of undergoing but very little change. Humus, on the other hand, is a substance that once possessed life, and consequently is always changing—being reduced—by decay. During decomposition a fair amount of ammonia, potash, lime, magnesia, and phosphates are set free for the use of crops, and certain organic acids are also formed from it, which have the power to attack the inert plant food in the mineral parts of the soil, making it available for the use of plants.

Humus has also the power to absorb and retain water, ammonia, and other elements of nutrition, and prevent their loss by drainage. Being of an open, loose nature it considerably improves soils of a clayey nature, making them more porous, and thus allowing air and water to percolate through them with greater ease. It also acts beneficially in soils of a sandy and chalky nature by making them capable of retaining more water and plant food. It also gives a dark colour to soils, for everyone must have noticed how differently a rich old garden soil looks which is full of humus, compared with a ploughed field, in which there is very little; and the darker the colour of the soil the more heat it will absorb from the sun's rays.

Amount of Humus in Soils.—The amount of humus in soils varies considerably. There is plenty of arable land which does not contain more than from 2 to 3 per cent. of humus, and, on the other hand, some land of a marshy nature will contain from 30 to 60 per cent. A good garden soil usually contains from 5 to 17 per cent. of this substance, but when this quantity is exceeded, the soil is very apt to become sour unless

A SPLENDID CROP OF POTATOES.

This crop produced a yield of 6 cwt. per square rod. Grown by the aid of artificial manures only. *See* pp. 91 and 125.

A PROLIFIC CROP OF OUTDOOR-GROWN TOMATOES.
For special manure formulæ *see* pp. 91, 126 and 129.

there is plenty of chalk present. The great value of old fibrous turf over ordinary garden soil is that it is full of dying and dead fibre which keeps it open, and contains a large store of humus which has accumulated by the decay of the roots and top growth over a long series of years, and is, therefore, rich in plant food, such being gradually liberated as the humus decays.

Humus and Soil Life.—The soil is not, as many suppose, a dead inert substance, but is teeming with millions and millions of tiny particles of life called microbes. There are different kinds of these microbes, each of which is doing some particular kind of work, for the most part changing those substances in the land which plants cannot utilise as food into a form in which they can do so. Without this soil microbe life plant growth would be impossible; and as time goes on and more knowledge is obtained about what they do, it will be found that farmers and gardeners will have to consider them in their soil work, and supply conditions necessary for their development.

The humus itself is of no direct feeding value to crops, but when broken down by microbes some of the products formed become plant food. Humus recently formed is attacked and partly broken down very readily; but the residue not attacked, and also that of any age, is only very gradually reduced. Not only is there a considerable quantity of plant food liberated from decaying humus, but certain acids are also formed, which are solvents, and have the power to attack some of the particles of mineral matter, and liberate from them the tightly-held potash, phosphates, and magnesia, so that the roots can absorb them.

Humus and Plant Food.—Humus, from its origin—that is, being composed for the most part of decaying vegetation—must be one of the chief factors in forming a fertile soil. The humus is full of the elements of food, that was absorbed from the air and soil by the plants which are now decaying. As this decomposition goes on, nitrogen in the form of ammonia is liberated, together with varying quantities of potash, phosphates, magnesia, and lime. When soil is mixed for pot plants care is always taken to get a plentiful supply of humus-forming material in the mixture, by the addition of decayed dung and leaf-mould. It is just as essential to see that a fair proportion is built up in the open soil, for the more humus a soil contains (up to 10 per cent.) the more fertile the land and the larger the crops, providing always that some form of lime is added to keep the soil sweet.

Mechanical Analysis of Soils.—A great deal has been said about the five principal constituents of soils, and considering the influence they have upon the character of the land, it is quite as well if the cultivator knows how to determine the quantity of these in any particular sample of soil. To do this accurate enough for ordinary purposes, take 100 ozs. of an average sample of the soil. This should be as dry as possible; the drier it is the more accurate the work. Separate the heap into two parts of 50 ozs. each.

To determine the amount of stones the whole of those, large and small, in one of the heaps, should be picked out and weighed, care being taken to remove any soil clinging to them. When the quantity is known in the one heap, it is easy to find out what there would be in 100 ozs. by doubling the result.

The amount of organic matter (humus) can be found by placing the remainder of the heap from which the stones have been taken on a large piece of flat sheet iron, which is placed over a good fire. The soil must be dry, or a great deal of the loss will be moisture, and will upset results. When the iron is red-hot, the heat passes through the soil, which should be spread thinly, and moved about carefully with a piece of wire from time to time, so that the soil in turn becomes also red-hot. When this stage is reached the iron plate should be removed, and after it and the soil have cooled, the latter may be weighed, the loss of weight representing the humus and water of combination. In calculating loss remember the stones previously removed.

The next thing to do is to take 10 ozs. of soil from the untouched heap of 50 ozs., and after removing all the stones, which later on must be added to the sand, put this into a large vessel containing about a quart of water. Water and soil should be thoroughly stirred up together, so that every tiny lump is broken into the minutest fragments. After stirring for some time allow it to stand perfectly still for about three minutes, when the heavy sandy particles will settle to the bottom of the vessel, and the clay, being lighter, will float in the water. Pour off very carefully the water in which the clay is suspended, taking care not to pour away any of the sand. Another quart of water should be added to the vessel, stir up again, and after allowing it to stand, pour off the clayey water as before. By repeating this process several times it will be found that the sand is free from clay, and the water will not discolour, showing that all the clay has been removed. When this stage is reached pour off all the water possible from the sand, and afterwards dry the latter, the stones can then be added, and the *difference*

between the weight now and the 10 ozs. taken, represents the amount of clay that was present in the soil.

It will now be easy to obtain a percentage composition of the soil ingredients. If the soil contained 3 ozs. of stones in the 50 ozs. of soil, the amount of stones in 100 ozs. would be twice 3, equal 6 per cent. If the loss on heating the remainder of the soil were 2 ozs., this multiplied by 2 would give the amount of organic matter (humus) as 4 per cent. Supposing it were found, after washing the clay from the 10 ozs. of soil, that the sand which remained, together with the stones, which were afterwards added, weighed 7 ozs., it would show that stones and sand multiplied by 10 equals 70 per cent., and the clay 30 per cent.; for as we only took 10 ozs., we multiply by 10 to get a percentage composition. Having arrived at this stage, it is easy to set out a table showing how things stand, not forgetting to deduct the stones from the sand and the humus from the clay. We can do this by taking away the amount first arrived at from the totals obtained at finish.

Stones 6 %	6 %
Sand 70 %, subtract 6 %, leaves	64 %
Clay 30 %, subtract 4 %, leaves	26 %
Humus 4 %	4 %
	100

Having arrived at the percentage composition of a soil, it is easy to see with what kind we are dealing by comparing the results with the following table:—

	Sand.	Clay.
Sandy (light to work) ...	80 to 95 % ...	5 to 20 %
Sandy loam	60 ,, 80 % ...	20 ,, 40 %
Loam (ordinary)	40 ,, 60 % ...	40 ,, 60 %
Clay loam	20 ,, 40 % ...	60 ,, 80 %
Clay (difficult to work) ...	5 ,, 20 % ...	80 ,, 95 %

How to Test for Lime.—To determine the approximate amount of lime in a soil, about 1 oz. of soil should be placed into a tumbler half-filled with soft water. Mix thoroughly, and then add ½ oz. of hydrochloric acid (spirits of salt), and if a strong effervescence takes place, it shows there is plenty of lime present; if little, it proves the soil needs an application of lime of some kind.

Chemical Analysis of Soils.—The work of chemically analysing a soil is so delicate and complex as to make it impossible for anyone but a qualified chemist to carry it out. The cost for a complete analysis varies from one to five guineas, but a great deal of useful information is sometimes obtained

by such means, and, what is of equal importance, a consideration of the work already done, will help to elucidate of what material a soil consists, that makes it valuable to cultivators.

Roughly, the top foot of an acre of land contains some 3,000,000 lbs. of soil. The chemical analysis of a turfy loam gave the following results :—

	Per cent.		Pounds per acre
Moisture	5·00	...	150,000
*Humus (organic matter) ...	7·00	...	210,000
Iron oxide	5·00	...	150,000
Alumina (clay)	6·00	...	180,000
Insoluble silicates (sand)	76·06	...	2,281,800
Lime	·25	...	7,500
Potash	·12	...	3,600
Magnesia	·13	...	3,900
Soda	·14	...	4,200
Sulphuric acid	·11	...	3,300
Hydrochloric acid	·09	...	2,700
Phosphoric acid	·10	...	3,000
	100·00		3,000,000
	·11 =		3,300

Looking at the foregoing analysis, and considering also the fact that at most no garden crop removes more in one season than from 100 to 150 lbs. of nitrogen, about the same amount of potash, half as much phosphoric acid, and less magnesia and iron, it might reasonably be asked why is there any need to apply fertilisers? There would not be any need if the food were in such a condition that plants could obtain and make use of it. All soils are made up in bulk of stones, sand, clay, and humus, and only a very small amount of fertilising matter is mixed with these, and that is scattered so intimately among the particles, and so much of it is in such an inert or tightly-held chemical form, as to be practically useless to crops. There is also another fact which must not be lost sight of, and that is the roots of crops do not penetrate through or around every particle of soil in the top foot. Some of them, like carrots, parsnips, etc., are restricted to a very small area; and in the case of peas, beans, celery, and leeks, the rows are wide apart, and consequently the bulk of soil in between is of very little value.

Nature requires something in return for what she gives, and in practice it is found that we always have to apply more fertilising matter to crops than is returned in the crop, if maxi-

*Containing nitrogen.

mum results are to be obtained. One hundred gallons of water can only dissolve out from the best of soils ½-lb. of soluble matter, and much of this is not actual plant food, so it can be seen how very small is the amount that crops have to depend upon.

The proportion of active plant food in even the most fertile soils is very small. An acre of land may contain thousands of pounds of plant food, but in such an inert condition as to be of very little use; but the addition of a fertiliser containing soluble nitrogen, potash, and phosphates, given only in small quantities, will produce excellent results, by enabling the crop time to gather material from the soil.

Absorptive Power of Soil Ingredients.—Each of the principal ingredients of soil has the power to absorb and retain water, but the amount absorbed varies considerably and depends upon which of the substances predominates. If 100 lbs. of the following soil materials—sand, clay, powdered chalk, or humus—were soaked with water, and weighed again after the surplus moisture had drained away, it would be found that each substance had absorbed or held in suspension a different weight of water. The 100 lbs. of sand would absorb 25 lbs., the clay 50 lbs., the powdered chalk 85 lbs., and the humus 180 lbs., of water; and further tests prove that a mixture of these absorb moisture in proportion to the quantity of each present. Thus 50 lbs. of sand and 50 lbs. of humus, mixed together, would absorb 102½ lbs. of water.

It is very important for cultivators to know this fact, for it shows them at once how the water-holding capacity of a soil may be increased or decreased according to the material used. If a soil be sandy and dry, the addition of humus will do a great deal of good, but care must be taken not to destroy it again by burning or applying quick or slaked lime. If lime is needed, apply it in the form of powdered chalk. If the soil is too wet, its water-holding capacity can be reduced by applying a material like sand. This, of course, would only apply to wet sticky clays and soils containing a large quantity of humus.

Soils not only have power to absorb water, but can also absorb many of the substances which are given in the form of manures. This is a good thing for both plants and growers, for if it were not for this property all the available fertilising material would be washed out in the winter, and the soil would be practically barren the following season.

If a solution containing soluble phosphates, potash, or ammonia, is poured upon a fertile soil, the water which drains through will be found to have lost these salts. They have

been absorbed by the soil, and this fact should not be lost sight of, for it enables cultivators to apply these substances at all times without fear of loss. Magnesia and lime are also retained by the soil, but are less tightly held than the foregoing.

The absorptive power of soils for plant food is partly chemical and partly physical. The land holds with great affinity such material as phosphates, potash, lime, and magnesia, but ammonia is held less strongly. Unfortunately, soils have no power to hold the most valuable of all fertilisers, viz., the nitrates. These are washed out with ease and lost, but such to a large extent could be avoided if some quickly-growing crop like mustard were sown on all bare pieces of land very early in the autumn. After the plants had grown and collected up the nitrates, they could be dug into the land, and would help materially to increase its fertility.

The surface of a moist, fertile soil is capable of absorbing ammonia from the atmosphere. Various minute algæ, and a bacillus in the soil, have the power of converting a certain amount of the inert nitrogen gas of the atmosphere into a form suitable for plants, but they can only do so in the presence of some decomposing matter.

How to Improve Soils.—If the facts regarding the material forming our soil, as stated in the preceding part of this chapter, are fully grasped, it becomes obvious to cultivators the means they must employ to improve the land they work. If the soil be of a light, sandy nature, it lacks that holding or absorbing character for water and plant food, and consequently is too dry and poor. The material to use to improve such soils must be something that will increase or improve its absorbing capacity. It has been shown that humus has the power to absorb nearly eight times as much moisture as sand. The grower should, therefore, endeavour to increase the amount of humus in the soil, and this may be accomplished by applying farmyard manure, leaves, and any material of an organic nature.

When the amount of humus is increased care should be taken not to destroy it again. A very common way of doing this is by applying quick or slaked lime to a sandy soil, which burns up the humus. Lime in some form is sure to be needed, but it should always take the character of pulverised chalk or limestone. Both these are mild forms of lime, and it has been shown that they, too, will absorb more than three times as much moisture as sand, and so by applying either of them two useful purposes are served—one, the addition of lime; the other, increase in the absorptive power of the soil.

When dung is given, apply that which is well rotted, and use a wet substance like cow or pig in preference to dry horse manure, for this will help to keep the soil close and compact.

A clayey soil is one too close and sticky, and is usually wet and cold. The material to use to improve such soils would be anything of an opening nature. Here, again, a store of humus is necessary, for although it be a great water absorber, it is a very porous substance. It is surprising how mellow a clay soil full of humus becomes, and how easy it is to work compared with an impoverished clay. Anything of a gritty nature, like sand and old mortar rubble, will help to improve the physical conditions of clayey soils. Burning a part of the subsoil in the summer months, and spreading this over the surface, has a beneficial effect, for burnt clay is similar to sand in character. Quick or slaked lime has a similar action to burning, and make the particles less sticky, for if two balls of wet clay are rolled up, and to one a little quicklime is added beforehand, these when dried will be found in the following condition. The one without lime cannot be broken without a lot of force, the other will break up into a powder. The dung for such soils should consist of horse manure, and the earlier applied the better, the long strawy material helping to keep the soil open.

Soil of a chalky nature can be improved by dealing with it in the same way as if it were of a sandy character. No lime will be necessary to this class, but if possible a little clay should be added, as this has a wonderful effect in improving the whole tilth.

Soils of a peaty, fenny, or boggy nature are perhaps the most difficult to treat when the amount of humus they contain is considerable. They are always of a sour character on account of the large quantity of vegetable acids formed in them. Anything in the way of sandy or gritty matter and old mortar rubbish will improve them, and the application of quick or slaked lime will be very beneficial, and keep them sweet.

PART II.

CLASSES OF MANURES.

CHAPTER V.

General Manures.

THE word manure is one frequently used, but its meaning is rarely understood. Used in its broadest sense, it means *any substance added to the soil to increase its fertility*. Other things being equal, the fertility of a soil depends upon its chemical, physical, and biological condition. The *chemical* condition should be of such a nature that the soil contains sufficient plant food to supply the needs of the crops grown, and the food should be in a well-balanced and available form. The *physical* condition depends upon the influence exerted by the different constituents of the soil. Thus a soil of a clayey nature is wet and cold, air and water percolate with difficulty; a sandy soil is dry and warm, and water and air enter freely; a peaty soil usually contains too much humus, and is sour. The *biological* condition means the invisible influences at work, chiefly of a bacterial nature, whereby many things for plants are prepared.

A manure, to fulfil its meaning, should be a substance that will improve in some way or other one or more of the conditions named above. Some manures, like farmyard, improve the chemical, physical, and biological conditions of a soil; others, like nitrate of soda, superphosphate, or kainit, only improve its chemical property; while, on the other hand, the use of lime may be beneficial to all three conditions, although it is a purely mineral substance.

Manures may be separated into two groups; one called *natural*, because they contain all the elements of fertility; the other called *concentrated*, because they contain a large bulk of purely plant-feeding elements. The present chapter will treat on the natural manures, leaving the concentrated for the three succeeding ones.

Farmyard Manure.—Farmyard manure is the oldest, cheapest, and most popular of all the fertilisers. Everyone feels

they can use this substance either in large or small quantities, and obtain satisfactory results. The reason for this is that good dung contains a fair proportion of all the ingredients that crops require as food, and being so diluted with water and carbonaceous matter, these ingredients are safe to use, for they will not burn or in any way injure any kind of growth, unless the strong fumes of ammonia, which may be given off from it when new, are allowed to escape in a closed glass-house or frame. Diluted down in the same way as dung, the most concentrated fertilisers could be used with safety.

Farmyard manure has a further advantage over purely chemical fertilisers, for it forms a lasting manure, and will improve the condition of any soil to which it be applied. There are a few exceptions to this rule, and they are old, rich garden soils already full of humus, and land of a peaty, fenny, or boggy nature. Farmyard manure does not act so beneficially on these as would a good dressing of lime and a well-balanced concentrated fertiliser. The bulk of the soils in this country are made up of different proportions of sand, clay, and chalk, and there is not a soil formed of these but what will be improved by an application of dung.

Composition of Farmyard Manure.—There is no substance which varies so much in character and composition as farmyard manure, although to outward appearance it seems to those who do not know to always be the same. A ton of good, well-made dung is worth two or three tons of an inferior article, and much of the stuff called by this name is little better than the same bulk of soil to which it is applied. From the day it is made until the day the last particles are used up, it is constantly being changed.

The substance known as farmyard manure is, properly speaking, a mixture of the solid and liquid excrement of horse, cow, and pig, mixed with some kind of litter, with probably a small quantity of poultry dung added. When properly made there is no better material than this, but the substance usually sold under the name of farmyard dung is horse manure only.

A ton of an ordinary sample of manure would be made up of some 16½ cwts. of water, and 3½ cwts. of dry matter. The 3½ cwts. of dry matter would contain about 12 lbs. of nitrogen, 12 lbs. of potash, 6 lbs. of phosphoric acid, 20 lbs. of lime, a little magnesia, sulphur, and iron. A ton of such material, even when good, only contains some 30 lbs. of active plant-feeding material, and it can be easily understood, when this is realised, why it is necessary to supplement the food by the judicious use of some concentrated fertiliser; and this is most

important when the crop is growing in restricted areas, as plants in pots, or fruit or roses in borders.

The quality of dung depends upon the variety of animal from which it is made, the kind of litter used, and the quality of the food given. The solid and liquid excrement of horses, sheep, pigs, and cows possesses different properties, as well as differing in chemical composition. The urine, as a rule, contains three times the amount of plant-feeding matter as the solid excreta. The following table shows how the material from the various animals differ.

1,000 lbs. of animal excrements contain the following constituents in pounds :—

Constituents.	Sheep.		Horses.		Pigs.		Cows.	
	Dung.	Urine.	Dung.	Urine.	Dung.	Urine.	Dung.	Urine.
Water	640	950	750	900	760	976	860	915
Solid matter ...	360	50	250	100	240	24	140	85
Nitrogen	7	10	5	11	6	3	3·6	9
Phosphoric acid...	5	·3	4	—	5	1·2	3	—
*Potash and Soda	3	16	3·5	15	6·5	2	2·2	14

It will be seen by looking over this table that the manure from sheep is the driest and, weight for weight, the richest in plant food of all the manures—with exception of poultry dung —produced on the farm, and next in order comes the horse, pig, and cow. Another thing which should also be noted is the entire absence of phosphoric acid in the urine of the horse and cow, sparingly present in that of sheep, but in fair proportions in that of pigs. From the absence of phosphoric acid the urine of these animals is of a very forcing and stimulating nature, and should not be given to fruit trees unless phosphates are added, or the growth shows it requires some stimulating material.

Another thing which should be noticed is the comparatively small amount of water and large quantity of nitrogen in sheep and horse manure, compared with cow and pig. This has a great influence on the fermentation of the dung, the two first being known as hot, dry manures, in contrast to the last two, which are cold and wet.

The Litter of Farmyard Manure. — The litter used will have considerable influence in the formation of good dung, and seeing how rich is the urine in plant food, the one that will absorb the most liquid will make—all things being equal—the best manure. The litters usually used are straw and peat moss, and sometimes sawdust and shavings. It very

* The water and solid matter equal 1,000 lbs., the nitrogen, phosphoric acid, and potash are present in the solid matter.

often happens that in the autumn a considerable quantity of leaves are collected and used for pig litter, and these are excellent material.

Wheat or oat straw will absorb three times its weight of liquid, sawdust four times, and peat moss eight times. A ton of wheat straw contains 10¾ lbs. of nitrogen, 6½ lbs. of phosphoric acid, and 12 lbs. of potash. A ton of sawdust, 6 lbs. of nitrogen, 6 lbs. of phosphoric acid, and 10 lbs. of potash. A ton of peat moss, 17 lbs. of nitrogen, 6 lbs. of phosphoric acid, and 20 lbs. of potash. Taking into consideration that peat moss is a good absorber, and contains also the largest amount of plant food, it ought to make the richest and best manure. There is no doubt it does, but the very fact of containing so much nitrogen makes it a substance which heats rapidly and intensely, and unless care is taken to guard against loss, much of its fertilising value being lost through the nitrogen escaping into the air. Peat moss when applied resists decay and gives rise to certain organic acids, which make soils sour, but this may be overcome by using plenty of lime.

There is no doubt that good straw dung is the best for all purposes. Manure containing sawdust or shavings is only fit for vegetable growing or field cultivation, and very little of it should be used if straw or peat manure can be obtained.

Fermentation of Manure.—When the excrements and litter from the animals are put into a heap a certain amount of heat, varying in intenseness, is developed. This fact is made of use by gardeners in making up hot-beds, for a bed or body of good dung will develop a large amount of heat, which will last for some time.

The fermentation is brought about by the action of various microscopic fungi, whose work seems to be to reduce the complex substances of the dung into more simple bodies. If it were not for these decomposing ferments, the dung would be of no value to crops. They break down the organic structure of the vegetable matter of which the dung is formed, and change it into certain organic acids, water, and ammonia. The principal acid is humic, and this combines with the ammonia, potash, or lime, forming humates of ammonia, potash or lime, and these in water form the dark substance which is frequently found running out of dung-heaps—called liquid manure.

The fermentation of manure varies, according to the kind of animal from which the dung was made. Horse manure heats rapidly, cow and pig with great difficulty. The heap should always be under control during decomposition, or a great loss may take place, either by it becoming too hot or too wet. When a heap gets too hot carbonic acid and ammonia are formed,

which unite and form a very volatile gas that passes into the air. When it gets too wet, the water washes the soluble part of the dung out. Both of these losses should be prevented, or the dung will be a very poor article, no matter how rich it was at the commencement.

If a heap is heating too much, and a smell of ammonia can be detected coming from it, this may be prevented by well treading it, or by the application of water or liquid manure. The heap should always be put up during wet weather, rick-shaped, so that it can never get too wet. If this has not been done, the liquid dung should be collected and applied to the land. Fermentation takes place more evenly when the heap consists of three parts horse manure and one part cow.

Fermentation Improves Dung.—New manure is not a good substance for plants; it is only of value to them after fermentation, although it may be applied to clay soils in a fairly fresh condition for the advantage of its mechanical action. During fermentation a heap of manure shrinks, the amount of shrinkage varying according to the time it is kept, but as a rule the heap will lose from 25 to 35 per cent. in weight after being kept from three to six months. If the manure is well made it will pay buyers to purchase decomposed dung in preference to new, always taking it for granted that the cost per load is the same. During the shrinkage the heap becomes mellow and concentrated, and will contain material in a more readily available form for the use of plants.

Use of Dung.—Farmyard manure is of the greatest value to all cultivated crops, and, with the exception of parsnips and carrots, there are no crops which do not benefit considerably from its use. The quantity to apply varies according to the nature of the soil. If the land be in good heart, about 16 tons per acre, 1 ton per 10 square rods, would maintain its fertility. If the land be poor, twice the amount could be used with advantage. When the quantity of dung is limited, and there is not sufficient to dress the whole of the land each year, a proper system of rotation of cropping should be followed, applying the dung to those crops which need it most. Celery, leeks, and peas must always be well supplied with manure. The crops to follow these should be carrots, parsnips, and beet. Cabbage, cauliflowers, onions, and lettuce also require a good supply, and if anything goes without it should be the potatoes.

When there is not sufficient manure to go round, crops will be better if the undunged portions of land receive a dressing of basic slag and kainit in the autumn or early spring,

and when the crops are growing two or three light dressings of sulphate of ammonia or nitrate of soda.

Dung for Potting or Fruit Borders.—The manure used for this purpose should be of the best. It should be well decomposed, and not dry, chaffy stuff. Fresh manure is not suitable, and if used, the products formed during its early decay may do a considerable amount of harm to young roots. The dung, if good, will have the best effect if mixed with the soil some time previous to use, so that soil and manure may blend together. For fruit or rose borders use well-rotted dung at the rate of one barrow-load to every six square yards when trenching. Afterwards a barrow-load to nine square yards will be sufficient. For flower borders, strawberry and raspberry beds, a good barrow-load to every twelve square yards will be a fair dressing. When mulching fruit trees do not pile the dung just round the base of the tree. Spread it evenly over the land to the extreme limit reached by the roots.

Liquid Manure from Dung Heaps. — Every grower who has used this substance, either for plants in pots, vegetable, fruit, or flower borders, knows how beneficial it is to crops. The reason for this is not far to seek, for it contains the very essence of the dung in a form easily assimilated by plants. According to Woolf, 100 lbs. (10 gallons) of an average sample consists of 98¼ lbs. of water, 10½ ozs. of organic matter, and 1 lb. 1½ ozs. of ash. The organic matter contains 2½ ozs. of nitrogen (equal to 1 lb. of nitrate of soda), and the ash 7½ ozs. of potash, 1-6th oz. of phosphoric acid, ½ oz. of lime, and 2-3rds of an ounce of magnesia.

It can be seen by this that while the liquid contains plant food of a mixed kind, the nitrogen and potash predominate, and consequently it is of a very stimulating nature. For fruit or flower growing some superphosphate should always be mixed with the liquid, 1 oz. to the gallon being a fair quantity to use. Liquid manure should always be diluted to the colour of pale ale before being used.

Night Soil. — Human excrements are very rich in the elements of plant food, containing more nitrogen, potash, and phosphoric acid than animal dung. They are not very suitable substances to apply to land, on account of the difficulty of using them. When mixed with plenty of soil and a deodoriser like sulphate of lime, a fairly powdery substance can be obtained, easy to apply. Its use should be restricted to vegetable growing or to hardy fruit trees.

Poultry and Pigeon Manure.—The dung of poultry and pigeons is very similar in character to ordinary guano, but

is nothing like so rich in plant food. The birds whose excrements form guano feed on fish, but the food of poultry is of a vegetable nature; nevertheless, the latter is one of the richest of the natural manures, being four times as valuable as the best farmyard dung. It is not an easy substance to use, being very sticky when new, and lumpy when dry and matured.

The nitrogen in the excrements is present as urate and carbonate of ammonia, two forms very liable to escape into the air and be lost. Poultry dung must be in a fairly dry and powdery condition if it is to be applied easily, but care must be exercised in preparing it, or the best part (the nitrogen) will be lost. The best means of dealing with it is to have a large tub or box, and put a layer from four to six inches deep as made, covering the surface with a thin layer of fine, dry soil. Layer after layer may be added until the receptacle is full, when after remaining so for a couple of months, it may be taken out, mixed, and passed through a sieve, when it will be ready for use. All fowl-houses should have a little quicklime sprinkled on the ground underneath where the fowls sleep. If this is not done, a little lime should be sprinkled with the dung when put into the box.

Poultry and pigeon dung thus made is very suitable for top-dressings to growing crops. Those which receive most benefit from an application are carrots, parsnips, onions, peas, beans, potatoes, and all kinds of fruit trees. The quantity to apply is 4 ozs. per square yard, 8 lbs. per square rod.

A very good liquid manure can be made by placing half a peck of it, together with the same quantity of soot, in a sack, and putting this in a tub containing 30 gallons of water. It will be ready for use in three days, and is suitable for any kind of crop. Throw the contents of the sack away, and renew every three weeks.

Poultry dung may be applied to fruit trees of every description just as it comes from the pen, but it should only be given to established trees, the rate being 1 lb. per square yard.

Green Crop Manuring.—A very good system of keeping up the fertility of the land is by green crop manuring. This method should appeal very forcibly to cottagers and allotment holders, and those who have gardens where dung is difficult to obtain. The practice is very simple, for it means that any piece of land, instead of being left uncropped for a month or so, is sown as soon as cleared with seed of some green crop, the length of time the ground would be bare determining what kind to sow. If only a short time will elapse before another crop is planted, seeds of some quick-growing kind like rape or

white mustard should be sown, but if the land is not required for several months, then vetches would be better.

When a green crop is sown, the plants as they grow collect and absorb all the soluble fertilising matter in the soil, and it is preserved instead of being washed out. The roots penetrate into the subsoil and collect food from there, which is brought to the surface for future use. Weight for weight, the green matter is considered nearly as valuable as farmyard manure. It should be the object of the grower to make as much bulk as possible, and this can be accomplished by sowing a mixture of equal parts of kainit and superphosphate at the rate of 2 ozs. per square yard, either just before or after sowing. The crop should not be allowed to get more than six inches high, when it should be dug in, burying it so that it will not interfere with future cultivation. Being succulent it will decay rapidly, supplying food to the general crops, besides keeping up a store of the valuable humus.

Brewers' Spent Hops.—In large towns brewers' hops can be obtained for next to nothing. They may be bought in London, free on rail, for 6d. a ton. The hops make very suitable material for applying to heavy land, not so much from a feeding point of view as from the value they are in keeping such soils open and making them work better—improving their tilth.

A very good substance for ordinary use, free from the objectionable smell of dung, may be made by sprinkling over a ton of hops 14 lbs. of sulphate of ammonia, 28 lbs. of superphosphate, and 7 lbs. of kainit, afterwards turning the heap twice to mix all together. This mixture will give as good results in practice as the best dung, and may be used for all purposes instead of manure.

Seaweed.—Growers living near the coast where seaweed can be obtained easily and cheaply, will find this a capital fertiliser for use in vegetable growing. Seaweed differs from farmyard manure only in respect to its organic structure, its tissues being soft and mucilaginous and not fibrous, and the tender organic matter, being of a very succulent and watery nature, decomposes quickly and easily, but does not form humus like dung.

It may be dug or ploughed into the land in a quite fresh condition, or may be allowed to dry somewhat to make it less bulky for carting, but if allowed to lie exposed to the air for any length of time nearly the whole bulk will shrink and disappear. Owing to this rapid decomposition its effect in the soil is not of a lasting character, and those who manure with seaweed find it necessary to repeat the application annually.

Its composition is similar to dung, one ton yielding 10 lbs. of nitrogen, 10 lbs of phosphoric acid, 30 lbs. of potash, and 50 lbs. of salt. The quantity to apply for garden purposes would be one cart-load to four rods of land, and for field cultivation from 10 to 20 tons per acre.

Vegetable Refuse.—All garden refuse, such as leaves, weeds, lawn mowings, and anything of a kindred nature, may be turned to good account by making them into a compost heap to rot, and sprinkling a layer of lime over the heap from time to time. All vegetable substances of a woody nature, like prunings from fruit trees, hedge clippings, pea and bean haulm, should be burnt, and the ashes added to the compost heap. The whole heap should be occasionally turned so as to mix together the different materials, and allowed to decay until it is of the consistency of leaf-mould. Urine or liquid from manure heaps may be added, which will enrich the whole, and make it more valuable.

It has been found that during the decomposition of such heaps, quite a fair amount of nitrate of potash may be formed in it, and this is one of the best fertilisers a grower can have. The heap should stand for several months, and may then be applied to vegetable land at the rate of one barrow-load to three square yards. Those who have difficulty in getting dung will find this method a good one for keeping up the store of humus in the soil, using in addition some concentrated fertiliser for feeding their crops.

CHAPTER VI

Manures containing Nitrogen.

WITH few exceptions the most expensive fertilisers are those containing nitrogen, for this substance in a combined form will cost anything from 9d. to 1s. per pound, even when large quantities are taken.

Nitrogen may be bought in fertilisers in three distinct forms, viz., (1) *organic*, (2) *ammoniacal*, and (3) *nitric*. Hoof and horn, and also dried blood, are typical examples of organic nitrogen, sulphate of ammonia and soot of ammoniacal nitrogen, and nitrate of potash, soda, or lime of nitric nitrogen. That this food can be bought thus is a good thing for growers, for by choosing the right material they can control their plant feeding. When making up fruit or flower borders, or potting up plants that must remain in the soil for a long time, an organic, or slow-acting form, like hoof and horn, is the material to use.

If, on the other hand, nitrogen must be applied to the land when it is being prepared for a crop, dried blood or sulphate of ammonia could be used, the soil having the power to retain both of these substances. It is waste of good material to apply nitrates except to growing crops, for they cannot be held by the soil, and so pass rapidly into the drainage water.

A mixture of both slow and quick-acting nitrogenous manures will give better results in feeding growing crops than either alone. The quick-acting supplies them with food for immediate use, the slow-acting sustains them until they are fed again.

Some Experiments.—Professor Albert tried some experiments on oat plants to see what difference there was in the feeding value of the various nitrogenous fertilisers. The results obtained were as follows:—

Fertilisers used.	Total weight of Plant.
No nitrogen	35·2 grammes.
Leather meal (steamed)	49·1 ,,
Leather meal (fermented)	75·1 ,,
Dried blood	87·8 ,,
Dried blood (fermented)	103·3 ,,
Horn meal (steamed)	143·3 ,,
Nitrate of soda	139·4 ,,
Sulphate of Ammonia	98·9 ,,

It will be seen that steamed horn meal did better than nitrate of soda; but Seyffert, in experiments on kohl rabi, found that while steamed horn meal produced 2,005 grammes, nitrate of soda produced 2,608 grammes. The table is useful for the purpose of comparison.

Microbes Make Nitric Acid.—When any form of organic nitrogen is applied to the soil, it is of no feeding value until completely changed. The soil is teeming with millions of tiny particles of life known as microbes, and some of these attack organic matter, and change the nitrogen into ammonia. Another class of microbes convert the ammonia into nitrous acid, and a third kind convert this into nitric acid. The nitric acid when formed chemically unites with lime or potash in the soil, and nitrate of lime or potash is formed, and this is the kind of nitrogen our crops feed upon.

If nitrates are applied to plants they can use them at once as food, but from what has been said it can be seen that ammonium salts and organic nitrogen must undergo certain changes before they are of any value, consequently they are not so rapid in their action as the nitrates.

Nitrate of Ammonia.—This is the most concentrated of all the nitrogenous fertilisers, for in 100 lbs. of it there are

35½ lbs. of nitrogen, equal to 42½ lbs. of ammonia. Very few manure merchants stock this salt, but it may be obtained from any wholesale druggist at about 6d. per pound.

Nitrate of ammonia is formed by the chemical union of nitric acid and ammonia, both of which are powerful stimulants, producing luxuriant leaf and stem growth. To those who wish to study the effect of nitrogen on vegetation this substance is recommended, for pale yellow foliage will change into a dark green colour, in from three to five days, if watered with a solution of this, ½ oz. in a gallon of water being the amount to use.

One of the very best fertilisers it is possible to produce can be made by mixing together equal quantities of nitrate of ammonia and phosphate of potash. The mixture produces a well-balanced food, containing 17½ per cent. of nitrogen, 12 per cent. of potash, and 40 per cent. of phosphates. It is easily dissolved in water, there is no smell from it, and will keep plants supplied with all the food they require. To those with a glass-house containing foliage or flowering plants, this will prove the best fertiliser they can use. The quantity to apply is ½ oz. in a gallon of water, given once a fortnight to all plants requiring food.

Nitrate of Soda.—Nitrate of soda is a most important substance for plant feeding, and is rich in soluble nitrogen. It is of a whitish crystalline nature, very similar in appearance to kainit or common salt. The nitrate is found as a crude deposit, mixed with other compounds of soda, in many of the rainless districts in South America. These mixed salts are dissolved, and the nitrate of commerce is separated from the impurities by re-crystallisation. It was first imported into this country in 1830, the quantity sent in that year being 850 tons, but now something like 100,000 tons per annum is sent to England.

Nitrate of soda is a powerful stimulant, and is useful for hurrying on backward crops, and will do a great deal of good if applied with care and at the proper time. Small quantities given at frequent intervals will do more good than a larger quantity applied at one dressing. It is a substance that will readily dissolve in water, and diffuses quickly through the soil, and upon that account must not be applied, unless there is a crop growing upon the land to absorb it, for soils have no power to retain a nitrate, and so it is easily washed out and lost.

100 lbs. of nitrate of soda should contain 15 lbs. of nitrogen, equal to 18 lbs. of ammonia; and this, being the only plant food found in it, shows that phosphates, potash, and lime ought to be present in the soil if good results are to be obtained. The fertiliser under notice is of a forcing, stimulating character,

and when used alone leaves and stem growth of a succulent nature are produced. It is, therefore, very suitable for applying to all crops like rhubarb, sea-kale, asparagus, celery, lettuce, leeks, spinach, and all the cabbage tribe, which are grown for their leaves, stems, or both. The quantity to use is 1 oz. to the square yard, 2 lbs. per square rod, at intervals of a fortnight. Scatter it evenly over the surface, and if it can be put on after rain so much the better. Two applications will be sufficient for most crops.

Pot plants with yellowish leaves, due to a lack of nitrogen, may be made to grow and produce green foliage by giving each one as much nitrate of soda as will lie on a shilling. Scatter it evenly over the surface of the soil after the plants have been watered, and allow at least a month to elapse before giving any more. If 1 oz. of nitrate of soda be dissolved in two gallons of water, a liquid manure suitable for most purposes can be made.

Nitrate of Lime.—Some six years ago Professor Birkeland, in conjunction with Mr. Edge, perfected an electrical process for making the oxygen and nitrogen gases of the atmosphere chemically combine, to form ultimately nitric acid. The acid is then brought into contact with milky lime, and the union of the two make the commercial substance called *nitrate of lime*, a most valuable food for crops.

100 lbs. of nitrate of lime contains 13½ lbs. of nitrogen, and the latter, being present as a nitrate, is absorbed by growing plants as soon as applied. All the compounds of lime have a tendency to produce stocky, firm growth; and we feel sure there is a great future for this new fertiliser; for while nitrate of soda is useful in the production of soft, succulent vegetation, the nitrate of lime will be found better for plants whose growth should be firm like roses, chrysanthemums, tomatoes, grapes, and fruit trees. The presence of the lime as a base is also good, for it has a sweetening influence on the soil.

The nitrate, like the other purely nitrogenous manure, contains only one active element of food, viz., nitrogen; and if it is to produce the maximum results, phosphates and potash should be present in the soil, or should be given in conjunction with this substance.

The quantity to apply is 1 oz. to the square yard, equal to 2 lbs. per square rod, and it may be used once a fortnight on growing crops requiring food of this kind. Like nitrate of soda, it must only be used on land where plants are growing and can take it up, for it is a substance easily washed away.

Nitrate of Potash.—Nitrate of potash (saltpetre) is formed by the chemical union of nitric acid with potash, and

makes one of the most valuable fertilisers it is possible to use. The great value of this substance lies in the fact that it contains two kinds of food—viz., nitrogen and potash; and further, that when given to plants, it passes directly into their roots in an unaltered form, and supplies two kinds of nutriment. It appears at first sight to be a very expensive manure, but on consideration this is not the case. One cwt. of nitrate of potash contains nearly as much plant food as would be found in 1 cwt. of nitrate of soda and 1 cwt. of sulphate of potash, and as the two together are only equal to 1 cwt. of saltpetre, there is scarcely any difference in them when their food value is reckoned up.

100 lbs. of commercial nitrate of potash contains 12½ lbs. of nitrogen and 40 lbs. of pure potash. When applied, it acts as quickly as nitrate of soda, and produces growth of a thick firm texture. Being a rich and concentrated substance, it should only be used for special purposes, that is, to any choice plants. It should be applied at the rate of 1 oz. in three gallons of water, once a fortnight, three applications in one season being sufficient. Foliage plants like palms, aspidistras, ferns, etc., would receive considerable benefit, if as much as would lie on a shilling were given to each pot (48's) once a month.

For general feeding, it is better to mix this nitrate with other fertilisers, because of the large quantity of potash it contains, but further instructions will be given in chapters on application.

Sulphate of Ammonia.—Sulphate of ammonia is the richest of all the commercial nitrogenous fertilisers. It is evidently a very popular manure from the fact that something like 200,000 tons is manufactured and sold annually in this country, the majority of which is made as a bye-product in the production of coal gas.

Coal contains from traces to 2 per cent. of nitrogen. When the coal is heated in the gas retorts the nitrogen is changed into ammonia, and is abstracted from the coal gas by being passed through water. The water absorbs the ammonia, and forms the *ammoniacal liquor* of the gas works, a substance which may be had for fetching away from some gas works, but, like fresh gas-lime, it contains impurities dangerous to the life of vegetation. The liquor may be used for putting on a compost heap, or may be put on spare pieces of uncropped land, three to four gallons per square rod being sufficient for one year, for if the liquor is good, this is equal to 4 lbs. of sulphate of ammonia per rod.

When sulphate of ammonia is made at the gas works, the liquor is heated, and the ammonia is driven off as a gas. The

gas is led through sulphuric acid, and the two substances combine to form the salt known as sulphate of ammonia. This salt is of a whitish powdery crystalline nature, and 100 lbs. of it should contain 20 lbs. of nitrogen, equal to 24½ lbs. of ammonia. The nitrogen being present as ammonia, is not so quick or forcing in its character as nitrate of soda; and as the soil has the power to retain the ammonia, it may be applied to the land before planting or seed sowing.

Sulphate of ammonia is a substance suitable for all kinds of soil, except those of a chalky nature, and may be applied at the rate of 2 ozs. per square yard, 4 lbs. per square rod, before planting; or the same quantity may be given in two applications to growing crops. Half an ounce in a gallon of water makes a good liquid manure. There is no food except the nitrogen in the sulphate, and unless used to stimulate crops, it will give better results when used in conjunction with phosphates and potash. Sulphate of ammonia does not penetrate so deeply into the soil as the nitrates, and therefore it has a tendency to keep roots near the surface, a good thing on cold, stiff, wet soils. This substance should never be used with quick-lime or basic slag.

Soot.—This is a substance that can be obtained in nearly every part of the country from the "sweep," and is a good fertiliser. We can understand why people living in cities and large towns are glad for the sweep to take the soot away; but why anyone with a garden gives him the same latitude is difficult to understand. The soot is good for all crops, especially seedlings when they are a few inches high, for not only does it supply them with nitrogen food, but also kills any slugs it may fall upon, and makes foliage bitter, so that birds and insects do not care about it.

The value of soot as a fertiliser lies in the fact that 100 lbs. of a good sample would contain from 2 to 4 lbs. of nitrogen. The nitrogen is present as sulphate of ammonia. Soot water is made by putting a peck in a sack, and placing this in a tub containing 30 gallons of water. After it has stood for a few days it is ready for use; but we are sometimes puzzled to know why people take the trouble to make this, for soot is not a pleasant thing to handle.

Soot contains nothing else of feeding value than the sulphate of ammonia, and this is always of a variable quantity, no two samples showing the same amount of nitrogen. A peck of good soot would contain 15 oz. of sulphate of ammonia. Well, then, why not put 15 ozs. of sulphate of ammonia in a tub with 30 gallons of water, and make a clear liquid, ready for use as soon as mixed, and always the same strength? A peck of soot is sufficient for a square rod of land.

Nitrolim (Calcium Cyanamide).—Nitrolim is a rich nitrogenous fertiliser recently put upon the market. It is made by heating calcium carbide to 1,000 degrees C., and passing a current of nitrogen gas from the atmosphere over it. The nitrogen and carbide chemically combine with each other, and *nitrolim* is formed. 100 lbs. of this substance contains from 18 to 20 lbs. of nitrogen, 24 lbs. of quick or caustic lime, 10 lbs. of carbon, and 15 lbs. of various mineral oxides.

Nitrolim is in the form of a very fine powder, similar to basic slag, and is of a greyish-black colour. When it is applied to the soil under ordinary conditions, it has the power to break up the water, the nitrogen in nitrolim combines with the hydrogen of the water, and ammonia is formed.

From numerous experiments carried out, both in this country and on the Continent, it has been found that nitrolim is nearly as good for plant feeding as sulphate of ammonia. The nitrogen is not liable to be washed out of the soil by rain, and so it can be applied some time before planting or seed sowing.

One advantage of using this manure as a source of nitrogen for crops is the amount of quicklime present in the material. This helps to keep the soil sweet, and the inert potash present in the land is liberated, and made available for the use of plants.

Blood.—Fresh blood, when it can be obtained near at hand, is worth taking a little trouble to procure, for it contains a fair amount of plant food. 100 lbs. of a fair sample contains from 2½ to 3 lbs. of nitrogen, 1 lb. of phosphate of lime, and ½ lb. of potash of magnesia. The substance itself is not a good one for applying to crops until specially treated, because when undergoing decomposition it gives off a very offensive smell, which may prove injurious to health. The fresh blood is better mixed with earth and made into a compost, such a substance forming valuable material for vegetable or fruit growing. Another way of preserving it is to dry it with slaked lime. To every gallon of blood add 1 lb. of slaked lime, and after stirring, put it into a shallow box, covering the top with a thin layer of lime. Leave it until the whole is dry, when it may be used for any purpose at the rate of 4 ozs. per square yard, 8 lbs. per square rod.

Dried Blood.—Dried blood is made from fresh blood by subjecting it to various processes to get rid of the surplus moisture. The red dried blood is that which has been carefully dried by hot water, but that which is of a darker colour is charred by being treated with a considerable amount more heat.

Dried blood is a fairly consistent fertiliser, and 100 lbs. of a fair sample contains 11½ lbs. of nitrogen, equal to 14 lbs. of

ammonia, a small quantity of ash, which contains lime, magnesia, potash, phosphates, and iron, all of which are valuable as plant food. The nitrogen in dried blood is present in an organic form, and must be changed before crops can use it, but this substance is of a nature that undergoes decomposition very readily.

Dried blood is one of the best forms of organic nitrogen, and can be applied to growing crops or sprinkled over the soil before planting. Being slow in its action it forms a lasting substance, either used by itself or in conjunction with ammonium salts or nitrates. The quantity to apply is 2 ozs. per square yard, 4 lbs. per square rod, or in a liquid form at the rate of 1 oz. in two gallons of water. It is a very good manure for all crops.

Dried Meat Azotin or Ammonite.—The different terms given above are synonymous with each other, and refer to a dried meat meal. It is seldom that this substance is used in this country, but on the Continent and in America it forms a valuable commodity. It is obtained from large rendering establishments where dead animals are dealt with, and also from the beef extract companies. It is very similar in composition to dried blood, but it is only suitable for applying and digging in previous to planting. It can be applied at the rate of 4 ozs. per square yard, and will suit all kinds of fruit, flowers, and vegetables.

Hoof and Horn.—Perhaps the best of all the organic sources of nitrogen is hoof and horn, for it is very slow in its action, yielding up food over a long period of time. It is a substance most suitable for applying and mixing with all kinds of fruit, rose, or flower border when they are being made, and for mixing with potting soil used for plants that are to occupy the same pots for many months.

100 lbs. of hoof and horn contains 12 lbs. of nitrogen, equal to 14½ lbs. of ammonia. It can be purchased either in the form of a very fine meal or in many degrees of coarseness. The larger the pieces the longer they take to come into use. When used for digging into fruit borders, 6 ozs. per square yard should be applied. For potting soil mix 1 lb. with every barrow-load.

A cheap local supply of hoof parings may often be obtained from the blacksmith. These can generally be bought, mixed with a certain amount of horse droppings, for about 6d. a barrow-load, and they are cheap when one considers that hoof from a manure merchant costs 12s. per cwt. Those fortunate enough to obtain this material should put several barrow-loads into a heap, cover it with soil, and allow it to stand for a few months, when it will make splendid material for flower

or vegetable growing, applied at the rate of three barrow-loads per square rod. We should advise it being used only for special purposes, unless an unlimited quantity could be obtained. It is excellent material for chrysanthemums, roses, grape vines, peach, and other fruit trees.

Leather.—This substance is sometimes ground up into a very fine powder and sold as a fertiliser, but although it contains as much nitrogen as soot, it is not much use to plants as food, because it resists decay, and the nutriment does not become available. There is one property it possesses which makes its use valuable on sandy and chalky soils, for it makes them very much like clay when used in a powdery condition. The particles of soil cling together and do not dry out so rapidly. When used 4 to 8 ozs. per square yard, 8 to 16 lbs. per square rod, may be applied.

Sundry Nitrogenous Substances. — There are many substances like shoddy, wool waste, scutch, hair, feathers, etc., which are useful sources of food, but are not on the market in sufficient quantities to make a general description of them necessary. When growers can obtain either of the above, they should use such material in the preparing of fruit or rose borders, or dig it into the vegetable garden, at the rate of ½ lb. per square yard, 16 lbs. per square rod.

CHAPTER VII.

Phosphatic Manures.

A.—Manures Containing Nitrogen and Phosphates.

The fertilisers containing nitrogen are more or less of a stimulating nature, producing greater vigour in the growth of plants, and so enabling them to absorb from the soil larger proportions of phosphates and potash. Those containing nitrogen and phosphates make a more complete fertiliser, for in addition to the stimulating nitrogen there are phosphates also present, which have the power to retard excessive leaf and stem production, and make plants produce more fruit and flowers. Then there is the class of fertilisers which contain only phosphates, and these may be used either by themselves to the soil when no crops are growing, to increase the phosphates in the land ready for future use, or applied to those plants or trees making too much leaf and stem growth at the expense of fruit. They may also be used for mixing with other fertilisers containing nitrogen and potash, when the grower is making up a complete manure.

The manures under notice are a very useful kind, for by a

proper choice of material the buyer can obtain phosphates in all stages of solubility, suitable for any kind of soil or any variety of crop. Those phosphatic fertilisers, which contain soluble phosphates like dissolved bones and superphosphate, are the most rapid in their action, and basic superphosphate is nearly as quick as the above. The other manures, like guano, basic slag, bone-meal, bone-black, bone-ash, and mineral phosphates, all contain insoluble phosphates, which become available when applied, in the order given. For growing crops it is better to use either dissolved bones, superphosphate, or guano, all of the others being more suitable for use before the crops are planted.

It will be found that, as a general rule, superphosphates are the best for chalky soil or that which contains much lime; basic slag for those of a clayey or loamy nature, rich garden soils, or those containing much humus like peaty, fenny, or boggy land; and bone-meal phosphatic guano for light sandy soils.

Guano.—Guano is the name given to material which consists of the excrements of sea-birds, dead birds, and feathers found in many parts of the world. The principal supply comes from the coast of Peru and the Chinchas Islands, but other parts of South America, and some parts of Africa, also send their quota.

This substance was first imported into England in 1841, the quantity sent in that year being 2,881 tons. To show how popular guano became with farmers and gardeners it is only necessary to give the amount imported ten years after. In the year 1851, 243,014 tons were sent into this country, but after that there was annually a big decrease, for the rich deposits had become exhausted, and that which did reach us had all sorts of material like sawdust, chalk, salt, sand, etc., mixed with it, and naturally it did not produce the results, and a bad name was given to it. These adulterations made the guano so poor in quality that in some cases it was almost worthless as a fertiliser; but all this has been altered, and anyone can buy the genuine article in the same condition as when taken off the rocks.

A high-class guano is one of the best fertilisers it is possible to use, for it is full of good things for crops. The quantity of plant food it contains is considerable, and the variety of forms in which it is present makes it a substance of a quickly-acting nature, and yet at the same time one that will last.

There are a numerous class of guanos on the market, varying very much in character and composition, and one has to be more careful over buying this substance than any other fertiliser. Naturally the value of any sample depends upon

the amount of *nitrogen*, *potash*, and *phosphates* it contains. The easiest way of determining if the substance is worth the money asked for it is to ask to see an analysis. When this is obtained, calculate its worth by taking the value of each per cent. of nitrogen at 1s., each per cent. of potash at 3d., and each per cent. of phosphates at 2d.

Speaking generally, there are two classes of guanos being sold, one called *nitrogenous* because they contain a large quantity of nitrogen, and a small proportion of phosphates, another called *phosphatic*, which contains a small quantity of nitrogen but a large proportion of phosphates. The first class cost the most money because nitrogen is six times as valuable as phosphates.

The following are analyses of the two kinds of guanos, and show at a glance how they differ:—

	Nitrogenous.	Phosphatic.
Nitrogen	7 to 12 %	... 2 to 4 %
Phosphates	16 ,, 22 %	... 35 ,, 43 %
Potash	1 ,, 3 %	... 2 ,, 3 %

Dissolved Peruvian Guano.—All the best guanos contain carbonate and other forms of ammonia, which are liable to escape as a gas into the air and be lost. Some manure manufacturers add a little sulphuric acid to these, for this has the power of converting the volatile forms into sulphate of ammonia, and fixing them. The acid also attacks the insoluble phosphates, changing them into a soluble form, thereby making them more easily assimilated by growing crops. The dissolved guanos are a good class of fertilisers, and will be found better than raw guano for quick results.

Ammoniated or Equalised Guanos.—These are made by adding sulphate of ammonia to a phosphatic guano, the latter, being rich in phosphates and poor in nitrogen, is greatly improved by the addition. They form a very useful class of fertilisers, but are not so valuable as the best Peruvian or dissolved guanos.

Potassic Guano.—Very often manufacturers not only add sulphate of ammonia, but also one of the potash salts, to a low-grade guano, for this increases both the amount of nitrogen and potash, and when carefully compounded makes a well-balanced fertiliser, suitable for nearly every kind of crop.

The Application of Guanos.—All the guanos form excellent feeding material for the use of plants, and may be applied with advantage to all kinds of crops, no matter what sort of land they are grown upon. The right time to use them is either when the crops are growing and want feeding, or immediately before planting or seed sowing. The quantity to

use is 2 ozs. to the square yard, or 4 lbs. per square rod; 1 oz. in two gallons of water makes a very good liquid manure. When guano is applied to growing crops it should be scattered evenly over the soil, and put on so that rain may wash the fertilising matter into the land. If rain does not fall the guano should be watered in.

Dried Fish Guano.—Some years ago the manufacture of fish guano, or fish meal, as it is sometimes called, was started in Norway, for one of the principal industries in that country is the extraction of oil from cod-fish caught around the coast. The bones, heads, and offal are first dried, and afterwards ground up into a fine meal, making the fertiliser we call fish guano. The same methods are now being followed with the refuse fish by manufacturers in this country, and the annually increased sales show that the substances must be supplying a manure giving good results.

Fish guano is sold in two different grades; one a low one, when 100 lbs. contain from 1½ to 2 lbs. of nitrogen, and 6 to 13 lbs. of phosphates; another of which the same weight would yield from 8 to 9 lbs. of nitrogen, and 16 lbs. of phosphates. The first of these, being so poor in plant food, is only suitable for applying to vegetable ground, fruit borders, or farm crops, 4 to 6 ozs. per square yard, 8 to 12 lbs. per square rod, or 12 cwts. per acre, being the quantity to apply. The higher grade is a very good fertiliser, and is suitable for grapes, tomatoes, cucumbers, strawberries, fruit trees of every description, and also for flower growing. The quantity to apply would be 2 ozs. to the square yard, 4 lbs. per square rod, once a fortnight during the growing season.

Fish manures will not keep for any length of time, and should be used as soon as possible, unless some means are taken to preserve them. This may be accomplished by mixing either 1 part of kainit with 3 parts of fish, or 1 part of sulphate of potash with 9 lbs. of fish. Not only does the addition of the potash salts help to preserve the fish, but also makes the manure a better balanced substance for use. The fish only contains nitrogen and phosphates, but the added salts supply potash.

The nitrogen in fish guano is in an organic form, and must undergo decomposition before it is of any use to the plants. It should, therefore, be applied some short time before the crops actually need food. During decay it gives off a very unpleasant smell, and should not be used too near dwelling-houses unless covered with soil.

The addition of sulphate of ammonia, superphosphate, and sulphate of potash to a fish guano, makes a very good fertiliser

suitable for all crops, for the mixture would contain soluble and insoluble nitrogen and phosphates, and soluble potash, and would form a quick-acting yet lasting substance. The quantities to use would be fish 5 parts, sulphate of ammonia 1 part, superphosphate 2 parts, and sulphate of potash one part. Apply at the rate of 1 oz. per square yard, 2 lbs. per square rod, once a fortnight to all crops requiring food.

Bones. — Bones were first used in Yorkshire about the year 1774. At that time they were applied in large pieces, but experience taught that the small pieces produced the best results, and consequently in 1829 Mr. Anderson, of Dundee, built machinery for grinding bones into ½ in., ¼ in., and bone meals. They may now be bought in all sizes, from very coarse to the finest possible meal.

Bones contain a small quantity of nitrogen, but they are bought chiefly for the large amount of phosphates they contain. 100 lbs. of a good sample should contain 45 to 50 lbs. of phosphate of lime, 4 to 5 lbs. of nitrogen, and 1 lb. of magnesia. The nitrogen is in an organic form, and the phosphates are insoluble. The bones are a slow-acting fertiliser, and must undergo various changes in the soil before they are of any value for plant feeding.

When bones decay the organic matter in them is changed into ammonia, carbonic, and other acids. The acids attack the insoluble phosphates of lime, and change it into a slowly soluble form. For reasons given bones are never used as a top-dressing to growing crops, but are applied to land when it is being prepared.

The best results are obtained when bones are applied to loamy, sandy, and peaty soils, and may be given with advantage to all kinds of fruit borders, rose beds, and to such crops as peas, beans, turnips, radishes, and flowering plants at the rate of 2 to 4 ozs. per square yard, 4 to 8 lbs. per square rod. The bones should be applied to the fruit borders or rose beds as a winter dressing, and to the vegetable land or flower borders in the spring, when the land is being turned over, and one of the fine meals should be used. When making a vine or peach border, or rose bed, ¼-in. bones should be used at the rate of 3 lbs. per square yard, or the same quantity to every cart-load if the soil has to be imported.

Potting soil, in which tomatoes, melons, or flowering plants are to be grown, will be considerably improved by the addition of 1 lb. of bone-meal to every barrow-load of soil.

Dissolved or Vitriolised Bones. — Dissolved bones are prepared by adding sulphuric acid to them. The strong acid attacks the insoluble phosphates, and makes them avail-

able for the use of plants. Bones are only useful for digging into the soil, dissolved bones may be used either for that purpose, or for mixing with other fertilisers to be applied as a top-dressing. When bones are put into chalky soils they decompose slowly on account of the large quantity of lime in the soil; it is, therefore, much better to use dissolved bones when land is chalky, marly, or contains much lime.

Dissolved bones do not contain so much plant food as raw bones, because the addition of the acid increases their weight, and consequently causes a decrease in strength. 100 lbs. of a fair sample should contain 2 lbs. of nitrogen and 28 lbs. of phosphates, 20 lbs. of which are soluble; but although there is less food, the same results will be obtained, if the same quantity as advised for bone-meal be used, because the dissolved bones are quicker in their action.

To decompose bones in small quantities, pack them layer by layer with wood ashes in a barrel, and keep the whole moist, not wet, either with water or liquid manure. In a few months' time the bones will come out in a fine powder, and form a useful fertiliser, which may be used in the place of bone-meal.

B.—Fertilisers Containing Phosphates.

Bone-Ash.—Bone-ash is a very rich phosphatic fertiliser, there being from 70 to 80 lbs. of phosphate of lime in every 100 lbs. of it. It is imported from South America, where it is prepared by burning large heaps of bones. When all the organic matter and the nitrogen is destroyed by the burning, a fine, whitish powder called *bone-ash* is formed. It is the material used by manure merchants in making the high grade superphosphates.

Bone-ash ought to be used by cultivators more than it is, for it forms a valuable fertiliser used at the rate of 4 ozs. per square yard, equal to 8 lbs. per rod, for all kinds of fruit trees and flowering plants. It is a substance especially valuable for old, rich garden soils, and those of a peaty nature. Owing to it being in the form of a very fine powder, the insoluble phosphate of lime is easily changed into a more active form by the soil.

Bone-Black.—Bone-black is made by putting bones in large iron retorts, and heating them by fire placed beneath the cylinders, similar to the process of making coal gas. The organic matter, instead of being destroyed, as in the formation of bone-ash, is changed into a very porous body, which covers the particles of bones, and forms bone-charcoal. It is made in large quantities for the use of sugar refiners, the bone-ash making suitable material for the removal of the colouring matter from crude sugar.

100 lbs. of an average sample of bone-black contain from 50 to 70 lbs. of phosphate of lime, and a small quantity of nitrogen. Manure merchants buy all they can for making into high-grade superphosphates, but there are places from where it may be obtained, and cultivators fortunate enough to get it should use it in the same proportion as advised for bone-ash.

Mineral Phosphates. — There are many sources of mineral phosphates, but the three most important are as follows :—(1) Coprolites, which are more or less rounded nodules, found in Suffolk, Cambridgeshire, and many parts of the world; (2) apatite,rock material, chiefly imported from Canada; and (3) phosphorite, a rock mineral, sent here from Norway and Spain.

All the mineral phosphates contain about the same proportion of phosphate of lime, which varies from 30 to 37 per cent., but they are all so hard as to be absolutely useless for use unless ground up into the finest possible powder. Even then bone-ash or bone-black is to be preferred. The mineral phosphates are the principal substances used by manure merchants in the manufacture of ordinary superphosphate of lime.

Superphosphate of Lime. — In 1840, Professor Leibig read a paper before the chemical section of the British Association, describing a process of dissolving bones by sulphuric acid. Mr. Thomas Proctor was present, and went home and started making the new manure, which he called *superphosphate of lime.* In 1842, Mr. J. B. Lawes patented a process for converting coprolites and mineral phosphates into superphosphate; and now, so important has this branch of the manure trade become, that more than a million tons are made annually in this country.

There are three grades of superphosphates upon the market —the *ordinary*, which contains from 25 to 28 per cent. of soluble phosphates, made from coprolites, apatite, and phosphorite; the *concentrated*, which contains from 35 to 43 per cent., made from bone-black or bone-ash; and the *double*, which contains 80 per cent. of soluble phosphates, made by first dissolving a low-grade phosphate with an excess of sulphuric acid, which, after filtering and concentrating the soluble portion, is used for treating a rich phosphatic substance like bone-ash.

The ordinary superphosphate is useful for applying to farm land, fruit trees, and for vegetable cultivation, but for the better class of culture the concentrated is recommended. When making up special mixtures for plant growing, or for applying to important crops, the double is the best, because it contains a large quantity of food and less insoluble residue.

Very often fruit trees grown on chalky soil produce foliage

of a pale yellowish-green colour, which lacks substance, and this is partly due to the fact that the excess of lime prevents the trees obtaining the phosphates they need. Growers with trees of this description would do well to apply 1 lb. of the concentrated or ½ lb. of the double to each tree, once in June, and again in August, and water it in. Superphosphates contain only one kind of food—viz., phosphoric acid; they produce the best results when given in conjunction with nitrogenous and potash fertilisers. They may be used on all kinds of soil, but give the best results on sandy, loamy, and those of a chalky nature. The quantity to apply is 2 to 3 ozs. per square yard, 4 to 6 lbs. per square rod.

Superphosphates should not be mixed with nitrate of soda, unless the mixture is going to be used at once.

Basic Superphosphate. — All superphosphates are more or less of an acid character, and will do more harm than good if applied to an acid soil, or one deficient in lime. Messrs. E. Packard and Co. have put into commerce a manure called *basic superphosphate*, a substance of a fine, white, powdery nature, which is basic in its action, and may, therefore, be applied to the soil, whether it be acid or not. The phosphates in the basic superphosphate are not so soluble as those in ordinary superphosphate, but they are more soluble than those in any other phosphatic fertiliser. 100 lbs. of basic superphosphate contains 25 lbs. of phosphate of lime. The quantity to apply is 2 to 4 ozs. per square yard, equal to from 4 to 8 lbs. per square rod, and it is suitable for all kinds of soil, and may be applied any time in the year.

Basic Slag.—In the year 1878, Messrs. Gilchrist and Thomas patented a process for lining with lime the inside of the converters used for changing iron into steel. In pig-iron there is from traces to 2 per cent. of phosphorus, and this must be removed before steel can be formed. The converters, which are the large vessels in which the pig-iron is placed, are lined with lime, and lime is also put into the metal when a molten mass. After the whole is well heated, a blast of air is forced through the molten metal, and the heat changes the phosphorus into phosphoric acid, which unites with the lime, forming phosphate of lime, and this floats on top of the metal, and when poured off forms the slag. For years this was allowed to accumulate at the works as useless, and it was not until 1883 that some articles appeared in a German paper pointing out how it might be made into a phosphatic fertiliser. In England at the present time, something like 150,000 tons are used annually.

100 lbs. of a good sample of basic slag should contain 17 to 20 lbs. of phosphoric acid, equal to 38 lbs. of bone phosphate,

50 lbs. of lime, 14 lbs. of iron, 8 lbs. of sand, and 5 lbs. of magnesia. There are many slags on the market, some of them almost worthless, therefore ask for an analysis before buying. The slag, to be of any value as a fertiliser, must be ground into the finest possible powder, and the best makers will guarantee their product to pass through a sieve having 10,000 holes to the square inch.

Basic slag forms an excellent phosphatic manure for clayey loams, rich garden soil, and land of a marshy, fenny, or boggy nature. It must be given some time before needed by crops so as to disseminate through the soil. The autumn and winter months are the best time for applying, and from 4 to 6 ozs. per square yard, 8 to 16 lbs. per square rod, is the quantity to use.

Basic slag should never be mixed with sulphate of ammonia or any of the guanos.

CHAPTER VIII.

Various Fertilisers.

IN addition to the fertilisers treated in the preceding chapters, there is a very important group which must be dealt with under various headings. This chapter will, therefore, deal with a somewhat mixed class of fertilisers, applied because they contain one or more of the following substances—potash, magnesia, lime, or iron.

A.—FERTILISERS SUPPLYING POTASH.

It has been known for a long time how valuable potash is to vegetation, but for years any material containing this substance was too expensive to use for applying to crops, and cultivators, until some 40 years ago, had no material they could use except wood ashes.

In 1857, when boring was being carried out at Stassfurt (Germany), for the purpose of finding common salt, rich and very extensive beds of potash salts were found, and since that time hundreds of thousands of tons of material containing potash have been exported to all parts of the world. The fertilisers containing potash most commonly used in this country are sulphate of potash, muriate of potash, kainit, and, to a smaller extent, carbonate of potash.

Sulphate of Potash.—This is a purified form of the mineral salt obtained from the Stassfurt mines, and is one of the best to use for all purposes where a concentrated substance is required. The best samples of the commercial article contain 50 per cent. of potash, which means there is 50 lbs. of pure

SWEET PEA, GLORY.

A four-flowered waved Spencer Exhibition variety. To create large flowers the plants must be fed with one of the special fertilizers described on pp. 72 and 107.

LILIUM AURATUM RUBRO-VITTATUM.

A popular hardy lily for pot or border culture. For a suitable fertiliser see p. 111.

potash in every 100 lbs. of the fertiliser. There are many less pure kinds of sulphate of potash sold, containing from 29 to 38 per cent. of potash, but good merchants only sell the best.

The sulphate is an excellent substance to use, very soluble in water, taken up readily by crops, and will mix well with all classes of fertilisers. It is the kind that should be used for all sorts of pot plants, fruit, flower, or rose borders, and will give the best results generally. It may be applied at any time of the year without loss, for all soils have power to hold potash and prevent it being washed out. The quantity to apply would be 2 ozs. per square yard, 4 lbs. per square rod, this being sufficient at any one dressing for all kinds of crops. If used in the autumn the winter rains will wash it into the soil, and cause it to disseminate among the soil particles, and crops can afterwards obtain it more easily.

Muriate of Potash.—This, like sulphate of potash, is a very soluble salt of potash, 100 lbs. of the commercial article containing 48 lbs. of pure potash. There is a great diversity of opinion among scientific men as to which of the two salts is the best, but practical experience leads growers to choose the former. There is probably very little difference between the two when used on outside land applied in the autumn, but for pot culture the sulphate is to be preferred. Theoretically it is the acid combined with the potash that is objected to, the sulphate containing sulphuric acid in combination with the potash, and when broken up in the soil, the sulphuric acid unites with lime, and forms sulphate of lime. The muriate contains hydrochloric acid in union with potash, and when liberated this acid would unite with lime, forming chloride of lime. Probably muriate is never applied in quantities large enough to form any appreciable quantity of chloride. The quantity to apply would be 2 ozs. per square yard, equal to 4 lbs. per square rod, but never apply muriate to potatoes or beet.

Kainit.—This is a potash salt, imported just as it comes from the mine, not purified in any way; consequently it does not contain so much potash as sulphate or muriate, the bulk being made up of several impurities. On some soils the impurities do a great deal of good. 100 lbs. of an average sample contain 23½ lbs. of sulphate of potash (equal to 12½ lbs. of pure potash), 14 lbs. of sulphate of magnesia, 12 lbs. of chloride of magnesia, and 34 lbs. of common salt.

Kainit is a cheap and useful potash salt for all farm crops, for the vegetable garden, and for outside fruit trees. It is better to apply it in the autumn, so that the rains may wash it into the soil, and during this period the common salt will be washed out. Kainit is too impure to use for pot plants, or

choice fruit or flowers, and should be restricted to the crops described above. The quantity to apply would be 4 ozs. per square yard, equal to 8 lbs. per square rod. For field crops, 4 cwts. per acre is a moderate dressing.

Carbonate of Potash.—Undoubtedly the best form of the ordinary potash salts is the one under notice, but unfortunately it is too expensive to buy for general use. For vine, fruit, and rose borders it is an excellent substance; but as it is of a caustic, burning nature, it must be given in the autumn, when there is no root action, and must not be sown on the plants. The quantity to apply would be 2 ozs. per square yard.

Owing to its caustic nature, it will kill many of the soil pests, and this makes it an excellent substance to mix with potting soil, if used a few weeks before the soil is needed. The quantity for this purpose is 7 lbs. per cart-load (one ton) of soil mixture.

Wood Ashes.—The cheapest source of potash is undoubtedly that obtained from wood ashes, and this has the advantage of being in the form of carbonate of potash. It will be seen how necessary it is to take care of these ashes when it is known that 100 lbs. contain from 5 to 15 lbs. of carbonate of potash, 5 lbs. of phosphate of lime, and some 40 lbs. of quick and carbonate of lime. Anyone having command over plenty of good wood ashes need never buy potash salts, but they must not be applied to stiff, heavy soils, for they would make them more sticky. To sandy, chalky, or fenny land the wood ashes can be applied at the rate of from 4 to 8 ozs. per square yard, equal to 8 to 16 lbs. per square rod. The ashes should be kept in a dry shed or other place till required, and applied, if only obtainable in limited quantities, to the land just before sowing seeds.

Magnesia.—It is very seldom that it is found necessary to apply salts of magnesia, but there are certain crops which require a fair proportion of this substance, and if it is not present in the soil in sufficient quantity, their growth is unsatisfactory. If the crop is known to be well supplied with nitrogen, and the foliage remains pale and undeveloped, it shows that most probably a little magnesia would do good. When kainit is used there is never any need to apply magnesia, for it contains a good percentage of it, but when growers feel in doubt about their plants having sufficient, they should try an experiment on a few plants.

B.—Manures Supplying Lime.

The fertility of soils depends to a considerable extent upon the presence in them of fair quantities of chalk or carbonate of

lime, and unless the land contains a sufficient supply of this material, fertilisers will not produce good results, and more or less diseased conditions or insect troubles are sure to make their appearance in the crops grown.

Lime performs many duties in the soil, the chief among them being the liberation of potash, keeping the land in a sweet state, due to the neutralising and removal of the vegetable acids formed during the decay of the humus, and it also forms that basic condition so necessary for the development of the nitrifying bacteria. Too much stress cannot be laid upon growers of the necessity of seeing that their soils are well supplied with lime in some form or another, especially when the land has been heavily dunged for a number of years. Test the soil for lime with hydrochloric acid, as advised on page 33, before any fertilisers are applied, and in nine cases out of ten the result will show, unless lime salts have recently been given, that lime is needed, and it must be given if satisfactory crops are to be obtained.

There are many different forms in which lime may be applied, each having something to recommend its use. The material nearest at hand will also have some influence upon cultivators as to what kind they will apply. It must be remembered that there are many soils which contain abundance of lime salts, these being those of a chalky and marly nature, and others found in limestone districts.

Quick or Caustic Lime.—Lime is never found in a free state in nature, for its properties are caustic, and shows that it will readily combine with an acid to form a neutral salt of lime. By far the largest quantities of lime on the earth are in the form of a carbonate. In many parts of the country large masses of limestone rock are found, in some cases thousands of feet through them. Another large deposit of this substance is the vast bed of chalk found in many parts of the South and South-East of this country. These two sources of carbonate of lime are those from whence the lime burners obtain the material for making quick or caustic lime.

The following table will show the composition of two limestones and a white chalk:—

	Ordinary Limestone.	Magnesium Limestone.	White Chalk.
Carbonate of lime	94·86	49·92	97·20
Carbonate of magnesia	1·26	36·23	·50
Sand	2·92	4·70	1·13
Iron and Alumina	0·73	7·92	1·05
Other substances	·23	1·23	·12
	100·00	100·00	100·00

Caustic or quick lime is prepared by burning limestone or chalk in kilns. The limestones or chalk, as the above analyses show, contain large quantities of carbonate of lime, i.e., lime and carbonic acid chemically united. When either of these compounds of lime are burned in the lime-kilns, the heat drives off the carbonic acid as a gas, leaving quick-lime behind. The *ordinary limestone* or *chalk* yield quick-lime of a fairly pure quality, but the magnesium limestones give a mixture of caustic lime and magnesia. Lime made from the ordinary limestones makes a good lime for all horticultural and agricultural purposes, but that from magnesium limestone is very detrimental to the growth of crops, and should not be used.

Quick-lime is an excellent substance to apply to all soils very rich in humus, like rich old garden soils and those of a peaty nature. It also forms the best kind for heavy, stiff clays, for it has the power to destroy the sticky nature of such, and make them more sand-like in character.

Lime in a caustic state, when brought from the kilns, is of a lumpy nature, and has to be slaked before it can be used. This weakens it to a considerable extent, but this difficulty can be overcome by buying "ground lime," that is, quick-lime which has been ground into a very fine powder by machinery. Nearly all builders' merchants stock this, and it costs very little more than lump lime.

Slaked Lime.—When lumpy, caustic lime is put into a heap and water poured upon it, a considerable amount of heat is developed. The lime and water chemically unite, and form a white powdery substance called *slaked* lime, but this action weakens the chemical action of quick-lime. A ton of newly-burned lime will absorb nearly 6½ cwts. of water, forming nearly 26½ cwts. of slaked lime. If this be allowed to remain exposed to the atmosphere for any length of time it will absorb carbonic acid gas from the air, and become carbonate of lime again.

Slaked lime may be used for the same purpose and to the same kinds of soil as quick or ground lime, the quantity to apply being 1 lb. per square yard, 28 lbs. per square rod, or 2 tons per acre. When applied it should be dug or ploughed in at once.

Chalk or Carbonate of Lime. — Chalk, limestone, and marble are composed chiefly of carbonate of lime. Chalk is a more or less soft form; limestone is harder; but marble is a true, hard, rocky substance not suitable for use. In many districts chalk can be obtained easily and cheaply, and makes splendid material for applying to soils of a loamy and sandy nature. It should be applied to the soil in the autumn, spread

broadcast over the surface of the land, and allowed to lie exposed to the action of the weather. Frost will help to pulverise it if used thus. If applied in the spring it should be broken up and passed through a half-inch sieve. The quantity to apply would be 2 lbs. per square yard, 56 lbs. per square rod, 4 tons per acre; but being such a mild form, it will do no harm if given in much larger quantities.

Until recently limestone was not a suitable substance to apply to soils on account of its hard, lumpy, and rocky nature; but the Dowlow Lime Company have erected machinery for grinding it up into a very fine powder, and in this condition it is excellent for use.

Powdered limestone or chalk should always be incorporated in soil used for growing pot plants (with the exception of heaths and azaleas), and also with that used for tomato, cucumber, melon, vine, or peach growing, 14 lbs. per cart-load of soil being the quantity to use. It also makes good material for using for roses, sweet peas, and other flowering plants (excluding rhododendrons); and in the vegetable garden peas, beans, and potatoes should always have a good supply.

Calcareous Sand and Shells.—In some parts of the country near the coast a good source of carbonate of lime may be obtained in the form of calcareous sand and pulverised sea shells. Oyster shells broken up into a fine powder also serve as a supply of carbonate of lime. The latter unbroken are better than broken pots for crocking pots before potting plants. About 3 lbs. per square yard, 1 cwt. per square rod, is the quantity of calcareous sand or shells to use.

Marls.—Marls vary very much in composition, but they all agree in being composed in varying proportions of sand, clay, and carbonate of lime. The quantity of carbonate of lime differs in various localities, some only containing 5 per cent., others as much as 80 per cent. If marls contain anything over 20 per cent. of carbonate of lime, they could be applied to sandy, loamy, and even to peaty soils with advantage, from 7 to 14 lbs. per square yard, 3 to 4 cwts. per square rod, 20 to 30 tons per acre being the quantity to use.

Sulphate of Lime.—Sulphate of lime, known also by the name of gypsum, is composed of sulphuric acid, lime, and water, chemically united. When applied to soils it has the power to decompose the tightly-holding silicate of potash liberating the latter for the use of crops. It also has the power to fix ammonia, not only in the soil, but also in manure heaps, and is a good substance to apply to dung or compost heaps to prevent loss of ammonia. It may be used for all gardening

purposes, but it is not so good as chalk, the latter being of greater value.

Gas-Lime.—Gas-lime under certain conditions may be a useful source of lime to apply to soils. When obtained fresh from the gas-works it is a mixture of caustic lime, carbonate of lime, sulphide and sulphite of lime, there being some 20 lbs. of the last two in an average sample. Both sulphide and sulphite of lime are deadly poisons to all kinds of plants, and must never be applied to growing crops, fruit trees, or land which is soon to be cropped. By exposure to the atmosphere both these forms change into sulphate of lime or gypsum, and then gas-lime is beneficial. On account of the harmful properties of gas-lime it should only be used for vegetable land, and applied as early in the autumn as possible, spreading it evenly over the land, and allowing it to lie exposed during the whole of the winter months. In this way, land tainted with insect or fungoid pests, and even the seeds or seedlings of weeds, may be cleared of them by a judicious use of this substance. 1 lb. per square yard, 28 lbs. per square rod, 2 tons per acre, is the most that should be used.

Fertilisers Containing Iron.—In some books on manures a great deal has been written to try and prove how valuable sulphate of iron is to crops. There is no doubt that a very few soils are deficient in soluble salts of iron, and upon such an application of sulphate would do a great deal of good; but, as a general rule, most soils contain an abundant supply, for plants only require a very small quantity, and this they obtain with ease. The land most probably short of iron will be light (whitish) coloured sands, and those containing a large quantity of chalk. The best test is the colour of the foliage of plants. If they are pale green, and the grower applies soluble nitrogen, and this does not change the colour into a dark green, it shows magnesia or iron is needed. Try magnesia in conjunction with nitrogen, and if this does not improve things, use sulphate of iron, either in water at the rate of 1 oz. in 3 gallons of water, or the same quantity by itself to every square yard.

Salt.—Although this substance is always found in all vegetable tissues, yet it has been proved that salt is not essential to the growth of crops. There is no doubt, however, that an application of salt improves the growth of crops like asparagus, beet, mangolds, sea-kale, potatoes, and cabbages, but its action seems to be more physical than chemical. When salt is applied to soils it helps to make them retain more water, and liberates potash. It should be used with great care, for applied in large quantities it will kill vegetation. The quantity to apply would be 1 oz. per square yard, equal to 2 lbs. per square rod.

PART III.

FORMULÆ FOR VARIOUS CROPS.

CHAPTER IX.

Fertilisers for Plants and Lawns.

HAVING disposed of the subject of the various substances available for use as manures or fertilisers, we will now proceed to discuss the special mixtures or formulæ suitable for the various crops. In this chapter we shall deal with the principal hardy and greenhouse plants, also lawns. The limits of space prevent us doing more than the leading or popular kinds. For the rest any ordinary fertiliser will suffice.

A.—FLORISTS' FLOWERS.

Carnations.—Carnations are not lovers of a too free application of animal manures. For pot culture one barrow-load of well-decomposed dung to twelve barrows of soil is as much as should be used. To this should be added one barrow-load of old mortar rubbish, or half a barrow-load of pulverised chalk. When preparing a border outside, apply one barrow of rotten manure to eight square yards. If the soil be clayey or peaty ½ lb. of slaked lime should be added; if sandy, 1 lb. of pulverised chalk, per square yard of bed. In feeding carnations it is found that a purely mineral manure is better than one of an organic nature.

The following fertiliser will give excellent results:—1 part nitrate of lime, 1 part nitrate of potash, 3 parts dissolved bones, applied at the rate of 1 oz. in 3 gallons of water once a week, after the pots are filled with roots. If nitrate of lime is difficult to obtain, use ½ a part of sulphate of ammonia instead. The same fertiliser will be found suitable for border carnations, applied at the rate of 2 ozs. per square yard twice during the growing season.

Chrysanthemums.—To grow chrysanthemums well they must have generous treatment, not only as regards the soil mixture, but also in the amount and quality of the ferti-

lisers used for feeding. The soil used is generally a mixture of 8 parts good turfy loam, stacked some months previous to use; 1 part of well-decayed farmyard manure; 1 part of leaf mould, and ½ part of silver sand. If the soil be of a light sandy character the leaf-mould might be replaced by dung, and the sand omitted. In addition to the farmyard manure, the soil is improved by the addition of some more concentrated fertilisers, and experience has taught that the following will give good results:—

MANURES TO MIX WITH POTTING SOILS.

Stiff Soils.

2 lbs. of basic slag.
1 lb. of fish guano.
½ lb. of sulphate of potash.
3½ lbs. of slaked lime.

Chalky Soils.

2 lbs. of dissolved bones.
1 lb. of hoof and horn.
½ lb. of sulphate of potash.
48 pots full of soot.

Sandy Soils.

2 lbs. of bone meal.
1 lb. of hoof and horn.
½ lb. sulphate of potash.
3½ lbs. of powdered chalk.

Peaty Soils.

2 lbs. of basic slag.
½ lb. of sulphate of potash.
3½ lbs. of slaked lime.

The above quantities are sufficient for three barrow-loads of soil mixture used for final potting. They should be mixed thoroughly with the soil, and if this be done a fortnight before potting so much the better.

The analysis of the chrysanthemum shows that it contains a large proportion of nitrogen, phosphoric acid, potash, lime, and magnesia. The soil mixture as advised will contain sufficient feeding material to last the plants until the pots are well filled with roots. When root action has reached this condition, feeding with weak doses of liquid manures will help to keep the plants going. It is much better to start as early—consistent with root action—as possible, and feed over a long period with weak solutions, than to try to force matters by giving larger quantities at the end.

MANURES FOR FEEDING.

Stiff Soils.

2 parts sulphate of ammonia.
4 parts concentrated superphosphate.
1 part muriate of potash.

Chalky Soils.

2 parts dried blood.
2 parts fish meal.
2 parts dissolved bones.
1 part sulphate of potash.

Sandy Soils.

2 parts nitrate of lime, or soda.
1 part of dried blood.
4 parts dissolved bones.
1 part sulphate of potash.

Peaty Soils.

2 parts nitrate of lime.
4 parts concentrated superphosphate.
1 part sulphate of potash.

The quantity to use at first would be 1 oz. of the mixture in 3 gallons of water, applied once a week. The quantity should be increased about a month before flowering to 1 oz. in 2 gallons of water.

The chrysanthemum is a plant which requires a large amount of magnesia. Twice during the growing season give them a watering with 1 oz. of carbonate of magnesia in 2 gallons of water.

The above fertilisers are the best it is possible to use for general culture. More inferior articles are soot water, liquid from manure heaps, liquid manures made by soaking several kinds of dung in water. These substances can be made to give good results, but one never knows what strength is being given, and it is easy to get unbalanced growth by their use. Soot water is all nitrogen. When used, superphosphate and potash should be given alternately with it. The liquid from manure heaps is nearly all nitrogen and potash; superphosphate should be given at every alternate watering. Fowl manure is perhaps the most satisfactory of the various animal manures used for making liquid manure, but there is not much soluble fertilising matter than can dissolve out of this.

Perhaps the best of all the fertilisers when the grower does not want to go to much trouble is one of the best guanos, applied at the rate of 1 oz. in 3 gallons of water once a week.

Dahlias.—The land for dahlias should be of a rich, free nature, and is better if prepared in the autumn or early spring. Being of a somewhat succulent nature, only dung should be used when digging, applying this at the rate of a barrow-load to every six square yards. After planting, when the plants begin to grow freely, an occasional watering with diluted liquid manure will greatly assist them. Those desiring first-class flowers should begin to feed the first week in August. One of the best fertilisers for this purpose is a rich guano. It may be applied at the rate of 2 ozs. per square yard once a fortnight, or the same quantity may be dissolved in 3 gallons of water, and given to three plants.

When dahlias are making too much growth and not flowering freely, apply 1 oz. of basic slag to each plant. If, on the other hand, they are not making sufficient growth, give ½ oz. of nitrate of soda to each.

Roses.—Roses do best in naturally rich soil, in preference to one made rich at the time of planting by the addition of a lot of manure. When the land is poor dung must be applied, but care should be taken only to use that which is in a very rotten condition. If possible, half leaf-mould and half dung should be used.

The rose grows well in a sweet soil containing a fair amount of lime. When preparing the border or land, give ½ lb. of slaked lime to heavy soil, or 1 lb. of pulverised chalk to sandy soil, applying this quantity to every square yard. If the land be rich apply no dung, but if poor use one good barrow-load to every ten square yards. After the dung is applied, a small quantity (4 ozs. to the square yard) of bone-meal, and 2 ozs. of hoof and horn, may be scattered over the surface before digging in. Once roses are established and growing they may be fed regularly with advantage. The feeding should take place at two seasons of the year. In the autumn the beds should have the following mixture made up, and applied at the rate of 2 ozs. per tree:—3 parts bone-meal, 1 part hoof and horn, and 1 part sulphate of potash. After this has been applied and lightly forked in, a slight mulch of half-decayed manure should be spread round each tree.

In the following May the borders should have a second dressing; this time a different fertiliser must be used. The following is one of the best to use for the purpose:—2 parts sulphate of ammonia, 4 parts dissolved bones, 1 part sulphate of magnesia. Apply at the rate of 2 ozs. per tree after rain, or hoe and water it in.

Soil for pot roses should consist of a mixture of 8 parts loam, 1 part thoroughly decomposed dung, a slight sprinkling of lime, bone-meal, and soot. The best fertiliser for feeding pot roses is made by mixing together 2 parts best Peruvian guano, 4 parts dissolved bones, 1 part sulphate of ammonia, and 1 part nitrate of potash. Apply at the rate of 1 oz. in 2 gallons of water once a week from the time the shoots are 6 in. long until the flowers are formed. All kinds of liquid fertilisers diluted may be applied to roses with advantage.

Sweet Peas.—Nearly everyone grows sweet peas, but when well and badly-grown flowers are compared, it will be seen that much more pleasure might be obtained if a little more trouble and food were given to the plants. Sweet peas delight in a deep, rich soil, containing plenty of manure, plenty of lime, and plenty of phosphates. Given these conditions there is not so much need for after-feeding and watering, although the nature of the soil will to a certain extent be the determining factor as to how much of this is necessary.

Everyone agrees that the land must be deeply trenched for this crop. Before this is done the following manure should be applied to the land and well incorporated with the soil as the work proceeds. Farmyard manure should be applied at the rate of one barrow-load to six lineal yards of row, and accord-

ing to the nature of the soil, one of the following sets of fertilisers should also be added:—

Heavy Soil.	Chalky Soil.
4 lbs. of basic slag.	4 lbs. dissolved bones.
1 lb. of muriate of potash.	1 lb. of sulphate of potash.
Sandy Soil.	**Peaty Soil.**
3 lbs. of bone meal.	4 lbs. of basic slag.
1 lb. of sulphate of potash.	1 lb. of sulphate of potash.

The above quantities are sufficient for 30 yards run of row, it being found more efficacious to sow these on top of the dung, about 18 in. wide, where the peas will go when planted. In addition to the above, quick-lime should be applied to stiff, heavy, or peaty soils at the rate of ½ lb. per square yard, and on sandy soils use 1 lb. of pulverised chalk over the same area.

When the plants commence to flower much finer flowers will be obtained by feeding. The liquid from dung-heaps, diluted to the colour of pale ale, soot water, or home-made liquid fertilisers, may be given once a week. Either of the following make very suitable fertilisers for feeding purposes:—Peruvian guano, fish meal, equal parts of dissolved bones and sulphate of ammonia, or equal parts of dried blood and superphosphate of lime, the quantity to apply being ½ oz. per yard run of row once a fortnight, and if rain does not follow, water it in. Peas growing with short flower-stems show there is not sufficient nitrogen. When this happens, apply sulphate of ammonia at the rate of 1 oz. in 3 gallons of water, and apply this quantity to every yard run of row.

A very special fertiliser can be made for sweet peas by mixing together 1 part nitrate of lime or nitrate of soda, 4 parts dissolved bones, and 1 part of sulphate of potash. Apply at the rate of 1 oz. to the yard run of row once a fortnight, and well water it in.

B.—Flowering Plants in Pots.

It is almost impossible to mix up a special fertiliser for each of the different flowering plants grown, and in practice this is not necessary. A good mixture will suit quite a large group of them, and if the different plants grown are separated into a few groups, and fed according to the nature of the growth they make, this is all that is needed. The most common-sense way of dividing them is to group them as:— (1) Plants with soft, succulent stems, like calceolarias, primulas, cinerarias, begonias, gloxinias, etc.; (2) plants with firm stems, like fuchsias, geraniums, pelargoniums, bouvardias, etc.; and (3) plants with hard-wooded stems, like heaths, azaleas, camellias, gardenias, genestias, etc.

Plants with Succulent Stems (Group 1).—These object to being fed with concentrated fertilisers. The soil in which they are potted should be rich, one consisting of 6 parts of loam, 1 part of well-decomposed dung, and 1 part of leaf-mould. When the pots are filled with roots the plants may be fed with advantage; but soot water, weak liquid manure water (consisting of the drainage from manure heaps, diluted to the colour of pale ale), or cow manure water (made by placing a peck of fresh cow manure in a bag, and putting it in a barrel containing 20 gallons of water), are the materials to use. A very weak solution of sulphate of ammonia, or guano water, may be used when the grower has not command of the foregoing, ½ oz. in 3 gallons of water once a week being sufficient.

Plants with Firm Stems (Group 2).—These are made up of firmer material, and to get the best results a different soil mixture, and a different style of applying fertilisers, should be used. The soil mixture should consist of 8 parts of soil, 1 part of rotten dung, 1 part leaf-mould, and a little silver-sand. To every barrow-load of this add a 48-pot of bone-meal, the same quantity of soot, a sprinkling of lime, and 4 ozs. of sulphate of potash. Liquid manures will do these good, but the following fertiliser will build up better plants with a greater profusion of flowers than the weaker stimulants. Mix together two parts of sulphate of ammonia, 4 parts of dissolved bones, and 1 part nitrate of potash. Apply this at the rate of 1 oz. in 2 gallons of water once a fortnight, and afterwards once a week, as soon as the pots are filled with roots or the plants show signs of wanting feeding.

Plants of a Hard-wooded Nature (Group 3).—These vary very much as to the nature of the soil in which they grow. For information on this point growers must refer to Mr. T. W. Sanders' "Encyclopædia of Gardening." As a rule, they object to lime or lime compounds, and experience has taught that an occasional watering with soot water, alternated with weak guano water (1 oz. in 3 gallons of water) is all they need.

C.—Ferns and Foliage Plants.

The different plants grown only for their foliage are very numerous, but they all agree in what kind of food suits them best. This is nitrogen and potash, with an occasional weak application of some fertiliser containing phosphates. The best and cleanest substance to use is nitrate of potash (saltpetre); it may be given at the rate of 1 oz. in 2 gallons of water occasionally, or as much as will lie on a sixpence may be applied to each plant once a month. This should only be given to

established plants. The liquid manure from dung-heaps, soot water, but not fowl manure, may be given to all kinds of foliage plants with good results, diluting them before use. An excellent fertiliser is made by adding 1 part of nitrate of potash to 3 parts of Peruvian guano, and applying this once every three weeks, at the rate of 1 oz. in 3 gallons of water.

Asparagus.—Either of the above may be used effectively for feeding greenhouse asparagus, but the foliage so produced will be of a dark colour. To produce plenty of the straw-coloured fronds the following should be used. Mix together 3 parts of fish guano with one part of kainit, and apply 1 oz. in 2 gallons of water once a week during its active growing period.

D.—Miscellaneous Plants, Etc.

Orchids.—No better substance for feeding orchids can be made than that produced by Cookson's formula. This is made by dissolving 3 ozs. of nitrate of potash and 2 ozs. of ammonium phosphate in 3 gallons of water. When this is made, use 1 oz. of the liquid in a gallon of water, for applying to the plants.

Annuals.—Anyone who has seen what excellent results can be obtained by growing these in good soil, and giving a little attention to feeding them, must have realised that the extra pleasure is very well worth the small amount of extra time and attention. The list of annuals grown in gardens is very extensive, but they all agree in one thing, and that is they delight in a light, rich, porous soil. If the soil is heavy, gritty matter should be added, and if of a light, sandy nature, plenty of well-decomposed dung or leaf-mould should be given.

The soil should be prepared in the autumn if possible, digging it deeply, and applying dung at the rate of a barrow-load every five square yards. A sprinkling of quick-lime should be given to peaty and stiff soils, and a little powdered chalk to those of a sandy nature. Before planting out, or sowing seeds in the soil, sprinkle the following mixture over the surface and rake it in. Mixture:—1 part sulphate of ammonia, 3 parts superphosphate of lime, 1 part kainit. Apply at the rate of 2 ozs. per square yard.

Perennials (Herbaceous Plants). — It is not necessary to make up different fertilisers for each of the numerous groups of perennials. They may be treated on the whole as belonging to one great family, giving favourites a little more attention than can possibly be given to all. This class of plants usually have to occupy the same piece of land for a number of years.

Before planting the soil should be deeply dug and well manured, for the plants delight in deep, well-tilled, fertile soil. Soil of a heavy nature should have gritty matter like sand, old mortar rubbish, burnt soil, and, if very heavy, a little ashes added to it. On top of this put fairly fresh short stable manure at the rate of a barrow-load to six square yards, and sow over the same area 2 lbs. of basic slag and ½ lb. of sulphate of potash. For soil of a peaty nature the same directions should be followed, giving in addition 3 lbs. of quick-lime. Soil of a sandy nature should have well-decomposed cow or horse manure dug in at the rate of a barrow-load to six square yards, and also 2 lbs. of bone-meal, 2 lbs. of kainit, and 7 lbs. of pulverised chalk. Chalky soils should be dressed with well-rotted cow or horse manure at the rate of one barrow-load to five square yards, applying in addition 2 lbs. of superphosphate and 2 lbs. of kainit. The whole of the manures should be well mixed with the soil when the digging is done.

Established borders, when they are cleaned up, should have an annual dressing of well-rotted manure dug in at the rate of a barrow-load to ten square yards. A sprinkling of quick-lime will keep slugs and insect pests in check. The growth of the plants can be considerably improved by giving sulphate of ammonia or nitrate of soda at the rate of 1 oz. per square yard in May, taking care to keep it off the foliage. Any special variety of perennials should have guano water, made by putting 1 oz. in 3 gallons, and applying it once a fortnight to them during their active growing season.

Bulbs, Etc.—All plants of a bulbous nature, and there are a host of varieties, do best in a rich, friable loam, but this is not essential, as may be proved by the almost general way they will grow in any soil. If the soil is very poor the growth and flowers are weak.

When preparing the ground for planting, apply dung in a well-decomposed condition at the rate of a barrow-load to six square yards. It will also be well to apply basic slag at the same time, 1½ lbs. to six square yards being the quantity to use.

The best fertilisers for bulbs growing in permanent quarters are fish meal, guano, or the following mixture :—1 part sulphate of ammonia, 3 parts superphosphate of lime, and 1 part kainit. Apply at the rate of 2 oz. per square yard just as the bulbs are coming through the ground.

Lawns.—Very few people seem to realise that lawns, if they are to be kept in good condition, require periodic applications of fertilisers. The constant mowing and removal of the grass takes away a large amount of fertilising matter from the soil, and unless this loss is made good, moss, weeds, and a

poor grass growth is sure to follow. It is possible to tell by the appearance of the growing grass what substance will give the best results.

If there is much moss and a poor grass growth, it shows the lawn must be dressed with nitrogen and lime to put matters right. In the autumn slaked lime should be applied at the rate of 4 ozs. per square yard, and in April, and again in May, the surface of the lawn should have sown upon it sulphate of ammonia or nitrate of soda at the rate of 1 oz. to the square yard at each dressing.

If the lawn grass turns brown during dry weather, and bare patches are formed, it shows there is not sufficient humus in the soil to retain the necessary amount of moisture. The best way to remedy this is to apply to the surface each autumn for two or three seasons very rotten farmyard manure at the rate of one good barrow-load to every eight square yards of lawn. If this is done early the dung will be washed into the soil by the rains, and in the spring the rough material can be swept off, and a marked improvement will be seen even during the first season. If any readers object to dung, and can obtain leaf-mould, apply this at the same rate as the dung, after passing it through a 1 in. sieve. In the spring 2 ozs. of guano per square yard will do a great deal of good.

To keep a lawn in good order as regards its grass surface, and make up for the loss of the removal of plant food in the lawn mowings, apply 3 ozs. of basic slag and 2 ozs. of kainit per square yard any time in the autumn, and towards the end of April 2 ozs. of sulphate of ammonia to the same area. Basic slag has a tendency to make clover grow freely. If this is objected to, use fine bone-meal instead. Weeds in lawns would never be troublesome if plenty of fertilising material be applied as directed above.

CHAPTER X.

Fertilisers for Fruit.

A.—Apples and Pears.

The apple grows in almost any kind of soil, but how much better the crop does in some compared with others. There are, of course, a few soils not suitable for the growth of this fruit, but they are very few, and many growers have only themselves to blame for much of the inferior fruit one sees growing, bad management and starving the trees being two of the chief

causes for this state of things. How different the crop would be, both in quantity and quality, if a little attention were given to the soil to improve its mechanical condition, and to apply sufficient nutriment for the crop. Many growers seem to think that all that is necessary to do in growing apples is to buy a few trees, make holes in the garden, and put them in, and leave the rest to chance. Good apples are valuable, and more attention should be given to see that the soil is in the right condition, and to feed with suitable fertilisers when the trees require it. The above remarks apply to those who neglect their fruit trees; but, on the other hand, it is no uncommon thing to see trees in a very unfruitful condition owing to too generous treatment. In this case the fault is in applying the wrong kind of fertilisers.

Manuring Soil for Planting. — Ordinary garden soil that has been well manured for several years is very suitable for apple growing, and requires no addition of farmyard manure when planting. Poor soils, no matter whether they be sandy, chalky, or clayey, should have dung applied before the trees are put in, an ordinary barrow-load being sufficient for five trees. Let the dung be mixed with the soil, and not packed round the tree. A very important point is to see that there is a good supply of lime in the soil at planting-time. If not, use a pound of slaked lime in the soil for each tree planted in stiff soil and rich old garden soils, or 2 lbs. of pulverised chalk if sandy.

Manuring Second Year After Planting.—After the trees are planted no manures need be given the first year, but after one year's growth it is an easy matter to see what the trees require. If the growth made is satisfactory, it shows the soil is about right; but if the shoots are short and weak, a little dung should be lightly forked into the soil round the tree, a barrow-load to every six trees being the quantity to use. In the following May apply 1 oz. of sulphate of ammonia and 1 oz. of sulphate of potash to each tree. This should put matters right if the trees were properly planted. In some cases, especially in rich soils, the growth made is very vigorous and strong. To such trees apply 4 ozs. of basic slag in the autumn, for this will help to steady the trees, and prevent a too rapid production of top. If the trees grow strongly the first year after planting, they will grow more rapidly the second year, hence the need of starting early enough to check it. The treatment suggested should be followed every year, taking the appearance of the trees as a guide as to what to apply, until they commence to fruit.

Fruiting Trees.—Apple trees, when they begin to pro-

AN ARCH OF DOROTHY PERKINS ROSES.

For suitable fertilisers for feeding roses *see* pp. 71, 118, 127 and 129.

A WELL GROWN DECORATIVE CHRYSANTHEMUM.

A large-flowered single variety grown as a bush. A special formula for feeding Chrysanthemums appears on p. 69.

duce fruit, should have more generous treatment. The older the trees, and the more fruit they produce, the more food in reason should be given. In some American experiments it was found that 10 bushels of apples removed from the soil 1½ lbs. of nitrogen, equal to 10 lbs. of nitrate of soda; 1¾ lbs. of potash, equal to 15 lbs. of kainit; and ½ lb. of phosphate of lime, equal to 2 lbs. of superphosphate of lime. A little consideration of the amount of fertilising matter removed from the soil in 10 bushels of apples, will teach why large trees that have never been fed produce small fruit.

Trees in an unsatisfactory condition should have the soil examined. If it be found harsh and hungry apply well-decayed manure at the rate of one barrow-load to ten square yards of soil, and lightly fork it in. In addition to the dung use 4 ozs. to each square yard of one of the following mixtures, according to the nature of the soil:—

Sandy Soil.	Clayey Soil.
Equal parts of bone meal and kainit.	4 parts of basic slag, 1 part of muriate of potash.
Chalky Soil.	**Peaty Soil.**
Equal parts of kainit and superphosphate.	4 parts of basic slag, 1 part sulphate of potash.

This dressing, together with a little nitrogenous manure in June, will make the trees more vigorous and the fruit larger. Sulphate of ammonia or nitrate of soda can be used for this purpose, 1½ ozs. per square yard being the quantity to use.

The above recommendation applies to all trees of a fruiting size in poor health, but sometimes the trees are so vigorous that very little or no fruit is produced. Such trees require entirely different treatment. In this case, the land under each tree should receive a dressing of 2 ozs. of kainit and 4 ozs. of basic slag per square yard. No other manures should be given, and this treatment should be followed each year until a more fruitful condition is reached. In applying fertilisers to all fruit trees spread it all over the land as far as the roots extend.

Established trees in good health and productiveness will keep in that condition by an application of the following fertiliser, used at the rate of 2 ozs. per square yard every May:—1 part muriate of potash, 1½ parts of sulphate of ammonia, and 3 parts superphosphate of lime.

Apple and Pear Orchards.—The land ought to be in fairly good condition before attempting to plant. If this is the case no manure will be necessary when the trees are put out. If it be poor, then follow the advice given above as regards manuring. The usual practice is to apply manure very heavily to the land, and grow potatoes and cabbage for

two seasons, and then plant. If this plan is followed, 20 tons of dung, 10 cwts. of basic slag, and 5 cwts. of kainit per acre should be used.

B.—Bush Fruits.

Currants and Gooseberries. — The soil used for currants and gooseberries should be of a fertile nature. Ordinary good garden soil will be suitable for them, but if they are to be planted in land of a poor nature, farmyard manure should be applied at the rate of a forkful to each tree, or three barrow-loads to the square rod, or 20 tons per acre.

After the trees are established they should be fed according to the character of the growth made. If the amount is satisfactory, then give to each tree in the autumn 4 ozs. of basic slag and 2 ozs. of kainit; but, if poor, this should be supplemented by a dressing of an inch of good rotten dung, lightly pricked into the surface soil. In the early days of May sow under each tree 1 oz. of nitrate of soda, or the same quantity of sulphate of ammonia. Growers will be surprised at the way both currants and gooseberries respond to the above treatment; and no matter whether the fruit is produced for home consumption or for sale, the extra size and quality will be appreciated.

Raspberries.—The raspberry delights in a deep, friable, rich soil. If this is the character of the land no manure need be applied, but if it be of a poor quality apply good rotten dung liberally, from four to six good barrow-loads per square rod, equal to 20 tons per acre, being the quantity to use. The manure should not be buried too deeply, for this crop is a surface feeder, the mass of fibrous roots always being near the surface.

When the beds are established they ought to be manured every autumn as follows:—To every square rod apply to the surface three barrow-loads of well-rotted manure, 4 lbs. of basic slag, and 1 lb. of sulphate of potash. In the early summer, as soon as the raspberry is in flower, it will be found that better and larger fruit will be obtained by applying fish or Peruvian guano to the bed, at the rate of 3 lbs. per square rod. This system of manuring will ensure a good supply of well-developed fruit, and a satisfactory growth of canes.

C.—Stone Fruit.

Under this heading fruit trees, such as peaches, nectarines, apricots, cherries, damsons, and plums will be considered.

Apricots, Cherries, Plums, and Damsons. — All the stone fruit agree in one thing, and that is, the land must contain a good supply of lime if they are to grow satisfactorily and produce good fruit. If the soil be deficient in lime

a quantity ought to be applied before planting, using 1 lb. of fresh slaked lime per square yard for rich garden soils and those of a stiff, retentive nature, and 2 lbs. of powdered limestone or pulverised chalk on land that is sandy or of the character of a loam. The same quantity of the different forms of lime should be applied at the same rate to established trees once every three years.

In their young stage the trees should not be overfed with any nitrogenous fertiliser, or the growth made will be excessive. If the land at planting-time is fertile, no manures will be needed until the trees commence to fruit. Young trees in poor soil growing too slowly, and those in rich soil growing too fast, should be treated in the same way as advised for apples and pears.

Established fruiting trees would receive great benefit by applying to them every winter 1 lb. of bone-meal and 8 ozs. of kainit, if growing on loamy or sandy soils; 1 lb. of basic slag and 4 ozs. of sulphate of potash, if growing on stiff, heavy land; and 12 ozs. of superphosphate and 8 ozs. of kainit, if the soil be chalky. These fertilisers should be supplemented in June with from ½ lb. to 3½ lbs. of best fish meal per tree, according to its size, if the crop the trees are carrying is a fair one, but it should be omitted in a season when only a small quantity of fruit is growing.

Peaches and Nectarines. — The soil used for peaches or nectarines should be of a fertile nature, containing a good supply of carbonate of lime. The addition of much dung to make a poor soil rich enough, usually leads to the trees making excessive growth in the early stages, a thing to be avoided. When good fertile soil can be obtained of the nature described, nothing need be applied to it when the trees are planted; but if there is an insufficient supply of carbonate of lime, use chalk at the rate of 4 lbs. per square yard, when the soil is being prepared.

If the soil be poor it must have fertilising matter of some kind added, but very little animal manure should be used; the grower should rely more on concentrated fertilisers. To every yard of soil apply before trenching 4 lbs. of bone-meal, 2 lbs. of hoof and horn, and ½ lb. of sulphate of potash. If the soil be very poor, a barrow-load of well-decayed manure might be used to every six square yards. Chalk must be used as above if the soil be deficient in this substance.

After the trees have been growing for a year it will be an easy matter to apply manure if it be found necessary, but always keep the trees well in hand until they commence to fruit.

Fruiting trees must have fertilising matter applied every

year if they are carrying good crops of fruit. For trees in a normal, well-balanced condition, the following mixture, applied at the rate of 2 ozs. per square yard, when the growth is 6 in. long, and again after stoning, makes a good fertiliser. Mix together 1 part best Peruvian guano, 2 parts of dissolved bones, and ½ a part of muriate of potash.

If the trees do not make sufficient growth, and are inclined to produce too much fruit, apply a layer of good dung at the rate of a barrow-load to five square yards, and use the following mixture instead of the above :—1 part of nitrate of lime, 2 parts guano, 1 part dissolved bones, 1 part muriate of potash. If, on the other hand, the trees are making too much growth, use the following :—1 part nitrate of lime, and 4 parts bone-ash. In both cases the quantity to use would be 2 ozs. per square yard once a fortnight, after growth is 6 in. long, until three applications have been given.

D.—Grapes.

In the formation of vine borders it must be decided whether the natural soil in the house is suitable, or if this should be removed, and better soil be obtained to take its place. Many people make a mistake in thinking that only decayed turf can be used for vine borders. Some of the best grapes are growing in a fairly porous soil, and acres are planted and doing well in soil that was only a ploughed field before being covered with glass.

The great thing in making up vine borders is to obtain a good lasting mechanical condition, and also a good supply of plant food, in a well-balanced state. A fair amount of judgment is needed to secure these conditions ; but, once obtained, by good management grape vines will grow and fruit well for years.

Compost for the Borders.—When the soil in the house is suitable for making into a vine border, the following manure should be applied to the surface, and the soil should then be trenched over 2 ft. 6 in. deep, mixing them thoroughly with the soil as the work proceeds. To every ten yards of surface apply four barrow-loads of rotten farmyard manure, two barrow-loads of chalk, 28 lbs. of ½-in. bones, 14 lbs. of hoof and horn, and 14 lbs. of sulphate of potash. If old mortar rubble can be obtained, use four barrow-loads of that instead of the chalk, but neither lime rubble nor chalk need be used if the soil contains plenty of calcareous matter.

When the soil is not of a suitable character, and other has to be imported for the work, choose that which is of a friable, yellow, loamy nature, if possible. To every twelve cart-loads of

soil add half a cart-load of well-decayed manure, five barrow-loads of chalk, or double the quantity of old mortar rubble, 28 lbs. of ½-in. bones, 14 lbs. of hoof and horn, and 14 lbs. of sulphate of potash. Mix thoroughly before making up the border.

Grape vines are not the gross feeders that many people think them, for a ton of grapes only removes from the soil 2 lbs. of nitrogen, 3½ lbs. of potash, and 1 lb. of phosphates. Of course, in the production of the grapes there is also the laterals and leaves, which absorb about twice as much food from the soil as is needed to form the berries.

In practice it is found that good crops can be obtained from vines over a long series of years by the use of proper fertilisers. The soil, of course, must be in a fertile condition, containing plenty of available food during the early stages of growth. When the vines break in the spring the laterals grow very fast, and as soon as they are tied down the small bunches develop rapidly. There is, therefore, a very heavy strain upon the vine in these early days, and again later, between the first and second swelling.

Treatment for Established Vines.—If the vines are not in a satisfactory condition, remove the soil until the roots are reached, and take particular notice of its state when moving it. The unsatisfactory condition may be due to many causes, but most probably it will be due either to a too rich but sour border, or to the same not containing sufficient food. If dung has been used lavishly for many seasons without lime or chalk, the border is sure to be in a sour condition; but if very little or nothing has been applied, then the grower may know that his vines are starved. In the first case, no more dung should be applied for two or three seasons, but the borders should have sown upon them slaked lime at the rate of 1 lb. per square yard, pricking it in a fortnight later. This should be followed in six weeks' time by a dressing of pulverised chalk or ground limestone, using 2 lbs. per square yard, and allowing it to lie on the surface.

If no dung or fertilisers have been given, and the soil is in an impoverished condition, apply a barrow-load of dung to every three square yards, also half a barrow of chalk, and dig this into the surface soil deep enough to reach the roots without injuring them with the fork.

Vines in fairly good health should always have a winter and a summer dressing. The winter dressing should be given as soon as the vines are pruned, and for this purpose one or other of the following fertilisers should be given according to the nature of the soil.

Fertilisers for Winter Dressing:—

Sandy and Light Soil.	Chalky Soil.
1 lb. of hoof and horn.	1½ lbs. of hoof and horn.
2 lbs. of bone meal	3 lbs. of dissolved bones.
½ lb. of sulphate of potash.	½ lb. of sulphate of potash.
Stiff Soil.	**Peaty Soil.**
1 lb. of sulphate of ammonia.	3 lbs. of bone ash.
3 lbs. of basic slag.	5 lbs. of basic slag.
½ lb. of sulphate of potash.	½ lb. of sulphate of potash.

The above quantities are sufficient for nine square yards of surface, but in addition to these one barrow-load of rotten cow manure should be given to soils of a light, sandy, or a chalky nature, and one barrow-load of decomposed horse manure to stiff soils. All the manure should be applied, and forked into the surface of the border. Vines that have been overfed with dung might with advantage have a dressing of the above, but use no stable manure; and those which have been starved may, in addition to the dung as advised, have twice the quantity of artificial fertilisers. After they are dug in give the border a good watering.

Fertilisers for Summer Dressing.—As soon as the bunches are thinned the vines should have the first of the summer applications, and this should be repeated again after the first swelling is finished. It will be found advisable to mix up a fertiliser according to the nature of the soil, for better results are obtained by so doing.

Sandy and Light Soil.	Chalky Soil.
2 parts of dried blood.	1 part of dried blood.
2 parts of dissolved bones.	2 parts of fish guano.
1 part of sulphate of potash.	2 parts of dissolved bones.
	1 part of sulphate of potash.
Stiff Soil.	**Peaty Soil.**
1 part sulphate of ammonia.	2 parts of nitrate of lime.
2 parts of fish guano.	2 parts of bone ash.
1 part of bone ash.	1 part of sulphate of potash.

Mix the different fertilisers well together, and apply at the rate of 4 ozs. per square yard at each application, well watering in.

Very often there is some difficulty in getting grapes to colour properly. When this is the case, mix together equal parts of sulphate of magnesia and sulphate of potash, and apply 2 ozs. of the mixture to each square yard, and afterwards well water it in.

E.—Miscellaneous Fruits.

Strawberries.—Strawberries are usually allowed to occupy the land for three or four seasons. The object of the

grower when he plants is to produce large fruitful plants in the shortest possible time. This can only be done when the land is in a fertile condition, either by previous manuring, or by the application of a good quantity of dung before planting.

If the land has been heavily manured for the preceding crop, farmyard manure need not be applied before planting; but if the land be poor, dung should be applied at the rate of one barrow-load of well-rotted manure to six square yards, equal to 20 tons per acre.

When the beds are established, they should be mulched with long strawy manure at the end of April, so that the fertilising matter may be washed into the land for the use of the plants, and the straw left clean for protecting the fruit from dirt. When this is put on, scatter over the bed ordinary superphosphate at the rate of 2 lbs. per square rod, 3 cwts. per acre. Just before the strawberries come into flower, nitrate of soda or sulphate of ammonia should be applied at the rate of 2 lbs. per square rod, equal to 3 cwts. per acre. This practice will make the fruit larger in size and some days earlier in ripening.

Figs.—The fig grows best in a light soil containing plenty of chalk. If stiff soils are to be used, some substance of an opening, gritty nature, like old mortar rubble, sand, or burnt earth, should be mixed with it. In a free, rich soil the fig will make far too much growth, and the same thing happens if farmyard dung is used too freely. It is much better to build up the trees slowly; but if it is found that they are inclined to grow too slowly, and have a starved, stunted appearance, give them 2 ozs. of nitrate of lime per square yard, and well water it in. It is astonishing how soon the growth of vigorous, unfruitful trees is changed if no manure of a forcing nature is given. The trees may be made fruitful by giving them bone-ash at the rate of 4 ozs., or basic slag at the rate of 8 ozs., per square yard.

Trees carrying large quantities of fruit should have weekly applications of diluted liquid manure. If this cannot be obtained, use instead 2 ozs. of Peruvian guano or fish meal once a week. The time to feed is as soon as the fruit begins to swell, stopping as soon as it has finished swelling.

Melons. — The melon should always be planted in a naturally fertile soil, for it objects to one containing a large quantity of dung. When such a soil can be obtained, it can be improved by mixing 3½ lbs. of fine bone-meal, and a 48-sized pot of soot with each barrow-load. Melons will not grow satisfactorily in poor soil. If only poor soil is obtainable, good decayed dung at the rate of one barrow-load to twelve barrows of soil should be used with the bone-meal and soot.

The soil used for top-dressing should consist of one part of manure to six parts of soil, and a sprinkling of slaked lime. When the fruit has set, feeding with some kind of fertiliser should be commenced. The drainage from dung-heaps, diluted with five times its bulk of water, makes a good substance to use. When the grower cannot obtain this liquid, the following mixture should be used:—2 parts dried blood, 1 part nitrate of potash, 4 parts dissolved bones. Apply at the rate of 1 oz. per square yard run of border, or the same quantity in 2 gallons of water, once a week, until the fruit has finished swelling.

CHAPTER XI.

Fertilisers for Vegetables.

THE formulæ given below apply equally to crops grown in private and market gardens.

Artichokes (Globe). — This crop grows best when planted in a light, sandy loam. If the soil be of a stiff, heavy nature, plenty of decayed leaves or manure and gritty matter must be used to make it more open and friable. Globe artichokes respond readily to good treatment, and, as a rule, better heads or buds are obtained by using dung in conjunction with concentrated fertilisers. Before planting the land should be enriched by applying dung at the rate of four barrow-loads per square rod, and when this is spread, scatter over it 4 lbs. of basic slag and 3 lbs. of kainit, digging all the manures in deeply, and mixing them well with the soil. The soil in which the plants are growing should have nitrate of soda at the rate of 1 lb. per square rod scattered over it in May and June. Established plants should have basic slag and kainit applied in the autumn, and nitrate of soda in the summer, same quantities as advised above.

Jerusalem artichokes require no special treatment.

Asparagus.—Asparagus grows well in loamy and light soils, but heavy land requires some opening material like sand, old mortar rubbish, leaves, or well-decayed manure. The main object to be obtained in cultivating this crop is to produce good strong growth, so that the shoots which come up the following spring will be thick and succulent. This can only be accomplished by feeding well after cutting is finished, so that the growth made after June will be rapid and vigorous.

When making an asparagus bed, dung in a decomposed condition should be spread over the land at the rate of one barrow-load to five square yards, equal to six barrow-loads per square rod. Trench this well into the soil, and no other manure will be needed until the autumn. So soon as the dead tops are cleared off the beds, and the surface has been lightly pricked over, a layer of about one inch thick of partly-decomposed dung should be spread over it. In the following February apply 8 lbs. of kainit and 6 lbs. of superphosphate per square rod. In June apply 1 lb. of nitrate of soda per square rod, repeating this at intervals of three weeks, until 3 lbs. per square rod has been given. Instead of the above fertilisers fish guano and salt could be used, the quantity to apply being 7 lbs. of fish guano, 3½ lbs. of salt per square rod. Beds to which no fertilisers are applied should have the dressing of dung, and 3½ lbs. of salt per square rod in the autumn, and in the summer frequent applications of liquid manure.

Beans and Peas.—The bean and pea belong to the family of pod-bearers, and delight in a deep, rich soil. A good supply of dung should always be used when preparing the land for either of these crops, although this is not so necessary in the case of broad beans as it is for dwarf or runner beans, or for peas. The dung should be given to the land where the roots will grow, and not spread over all the land. For peas, runner and dwarf beans, spread five barrow-loads of well-decayed manure to 30 yards run of row. It will be found that if 4 lbs. of basic slag and 2 lbs. of kainit be scattered over the surface of every five barrow-loads that a larger crop of better-flavoured peas and more succulent beans will be obtained. If the land is in fairly good heart, all that is necessary to grow good crops of broad beans is to apply 4 lbs. of basic slag and 2 lbs. of kainit to every 30 yards run of row.

The pea and bean family have nodules on their roots, and the bacteria in these bring the atmospheric nitrogen into a form suitable for use of the crops. When dung is used no nitrogenous manure need be given unless the soil be of a hungry sandy nature, or contains much chalk. An application of 1½ lbs. of nitrate of soda per 30 yards run of row will be very beneficial to peas growing on these soils. On chalky soils superphosphate should take the place of basic slag. Fowl manure is very good for peas.

Beet.—Beetroot should always be grown in well-pulverised land fairly rich in plant food. If poor, rotten dung should be applied at the rate of three barrow-loads to 30 square yards in the autumn. The beet is a crop which requires fairly large supplies of nitrogen and potash, but if these are to do their

work phosphates must also be given. No matter whether dung is applied or not, the land to be cropped with beets should have 3 lbs. of basic slag and 1 lb. of sulphate of potash per square rod, applied in the autumn; and in June apply 1 lb. of nitrate of soda over the same area, repeating the application again in July.

Even poor sandy soil may be made to grow good crops of beet by applying double the quantity of fertilisers named above, or by applying 7 lbs. of fish meal per square rod just before sowing the seed.

Carrots and Parsnips.—These tap-rooted plants do not produce symmetrical or good-shaped roots on land recently dunged. The ground should be deeply dug and broken up, using that previously occupied by celery or leeks for preference. It is surprising how large the roots will grow in a very rich soil by the addition of only 3½ lbs. of fresh slaked lime per rod. Very much better crops of finer quality and size may be obtained on ordinary land if 3 lbs. of basic slag and 2 lbs. of kainit be spread over each rod of land before sowing the seed, and after the crop is thinned nitrate of soda is sprinkled over the bed at the rate of 1 oz. per square yard, equal to 2 lbs. per square rod. The cost is very little, and would be repaid over and over again.

Celery and Leeks.—These two crops are very similar in their mode of growth, their food requirements, and treatment. Both are usually grown in trenches; but what miserable specimens some are compared with others, the only difference being that the former have been neglected and starved, and the latter well fed. When grown in trenches the soil should be first thrown out, and then the bottom be well covered with 3 in. of dung, and this be dug in and intimately mixed with the soil. When this is finished sow about 3 lbs. of fresh slaked lime over the surface of 30 yards run of trench. A week before planting apply 3½ lbs. of superphosphate and 1½ lbs. of kainit to 30 yards run, for this will help to make the celery more crisp and firm.

After planting, as soon as the plants begin to grow freely, feeding may commence. Liquid manure, diluted with four times its weight of water, makes an excellent substance for the purpose, applied once a week. If this cannot be obtained, use nitrate of soda or sulphate of ammonia at the rate of 1 oz. to two yards' run of row once a fortnight, and water it in if rain does not follow. A week before earthing up use 1 oz. of best guano or fish meal in 3 gallons of water, and apply this to every yard of row.

Cucumbers. — The soil mixture used for cucumbers should consist of four parts of loam to one part of decayed stable manure, and a sprinkling of slaked lime. Cucumbers grow best if a top-dressing of soil is given once a week, a month after planting, the mixture this time being three of soil to one of dung, applying an inch at each dressing. To obtain large crops of fruit, feeding with a concentrated fertiliser should take place once a week after the first fruit is 6 in. long. Ordinary liquid manure, diluted with five times its weight of clear water, may be given for the purpose. Peruvian guano, at the rate of 1 oz. per plant, or the same quantity in 2 gallons of water, and applied to each plant once a week, is a very suitable substance; but the best substance is a mixture of 2 parts fish guano, 2 parts of sulphate of ammonia, 8 parts of a phosphatic guano (nitrogen 3, phosphates 40), and 1 part of sulphate of potash. Apply at the rate of 1 oz. per yard run of border once a week after the first fruit is 3 in. long.

Eschallots (Shallots).—These should be planted on a fairly rich piece of ground, that heavily manured for the preceding crop being best. Firm, solid bulbs of good size can be obtained by applying 3 lbs. of superphosphate and 2 lbs. of kainit per square rod before planting, and when the crop is growing, 1 lb. of nitrate of soda over the same area. Instead of the above, fowl or pigeon dung could be used, applying 4 ozs. per square yard, or 8 lbs. per square rod, when preparing the land for planting.

Green Crops. — Under this heading cabbages, cauliflowers, broccoli, savoys, Brussels sprouts, and plants of a kindred nature will be treated. All these crops do best on rich soil, and poor soil must have a good dressing of dung to make the growth satisfactory. The quantity of dung to use will depend upon the condition and fertility of the soil; two barrow-loads per rod for medium; four barrow-loads if poor, six barrow-loads if very poor, being the quantity to use.

Cabbages planted out in the autumn should be dressed with nitrate of soda the first week in April and the last, using 1 lb. per square rod at each application. Those planted in June or July should have 1 lb. of nitrate of soda spread over each rod of land just before the plants are put out, repeating the application six weeks after planting.

The same quantity of nitrate should be applied to early planted savoys and Brussels sprouts, applying it in the same manner as advised for summer-planted cabbage. Those which have to stand until late in the season should only have the first application; the second would make the growth too tender, and it would not stand severe weather.

Cauliflower and broccoli require a little different treatment, for in their case it is the flowers that are used. In addition to the dung, spread over every square rod of land 3 lbs. of superphosphate and 3 lbs. of kainit, and dig all in together. Nitrate of soda should be applied to cauliflower in the same way as summer cabbages, but do not apply this substance to broccoli. Kale, sprouting broccoli, etc., do not require anything other than dung.

Leaf and Stem Plants. — Lettuce, endive, and spinach are the principal crops grown, but they require no special treatment. A good rich soil is the best for either crop, and if not in this condition, apply dung at the rate of a barrow-load to five square yards, using only that which is in an advanced stage of decomposition. Both crops respond to nitrogenous fertilisers. A sprinkling of soot will be beneficial, or nitrate of soda can be used instead, at the rate of 1 oz. per square yard, 2 lbs. per square rod.

Onions.—Land most suitable for onions is a fertile loam rich in humus. They may also be grown on light soils if heavily manured. Stiff soils are not so suitable as the above, although very satisfactory crops may be obtained from them if plenty of opening material be applied. The land should be dug deeply for this crop, and farmyard manures should be used in the autumn if the soil is too poor to grow good crops without it. There is no crop that will respond more readily to good treatment than the one under notice, and growers who have never used concentrated fertilisers in conjunction with dung, should try the combination for onions, and see what heavy crops may be produced.

Dung should be used on all soils, except those which are naturally very fertile. The quantity to use will vary from four to six barrow-loads per square rod, according to the nature of the land. In addition to the dung, apply 3 lbs. of kainit and 5 lbs. of superphosphate to the same area, and dig the whole in deeply, mixing them well with the soil. Before sowing, scatter a little slaked lime over the surface of the land, 1 bushel per square rod being sufficient. After the final thinning apply 1 lb. of nitrate of soda, or the same quantity of sulphate of ammonia, per square rod, once a fortnight, until the end of July. Liquid manure might be used instead of the nitrate of soda, but the latter is more easy to use. When kainit and superphosphate are not given, the dressings of nitrate must not be used, for the onions will not keep.

Fish guano, applied at the rate of 2 ozs. per square yard, 4 lbs. per square rod, the first week in June, and repeated again

early in July, will well repay the outlay, and will help to produce good, sound, firm bulbs.

Potatoes.—Potatoes are grown on all kinds of land, but the crop varies very much, the heaviest weight being produced on rich, warm, friable soils. As a general rule, a combination of dung and concentrated fertilisers will give better results than either alone. The best manures for the purpose are the following:—1 ton of well-decayed dung, 28 lbs. of superphosphate, and 28 lbs. of kainit, applied to every eight square rods of land. No kainit need be given if the soil is a heavy loam, and basic slag should take the place of superphosphate on stiff and peaty soils. If the soil is rich in humus (e.g., fenny or peaty), no farmyard manure should be applied, but the fertilisers named above be given, for they will make a better balance in the soil food. If the land is in very poor condition, spread carefully over the surface just before planting 1½ lbs. of sulphate of ammonia for stiff land, or 3 lbs. of fish guano per square rod if the soil be sandy or chalky.

Rhubarb.—This crop is usually planted in fairly rich soil, and remains in the same place for a number of years. Every autumn, when the stalks die down, the surface of the bed should be lightly pricked over, and given a coating of about two inches of manure. During the summer an occasional watering with liquid manure should be given. Rhubarb growing in soils containing too much nitrogen produces stalks green in colour. If 2 ozs. of superphosphate, and the same quantity of kainit, be applied to each square yard in the autumn, very much better growth will be obtained.

Seakale.—This crop will grow well in almost any kind of soil; in fact, any land that suits cabbages will produce seakale. The growth to produce good crowns cannot be made too fast or too vigorous, and to obtain this the land should be manured with four barrow-loads of good dung per square rod. This is a crop which receives great benefit from potash and common salt. If kainit be given it will supply both, the quantity to use being 3 lbs. per square rod, applied with the dung. Two dressings of some nitrogenous fertiliser should be given when the crop is growing. June and July will be the best months for this, using 2 lbs. of nitrate of soda per square rod at each application.

Tomatoes. — Two systems are followed by tomato growers in the production of tomatoes, one to mix up soil, and plant out in pots, boxes, or barrow borders; the other to plant out in the natural soil. When the first of these methods is

followed, the soil mixture should be one part of well-decayed dung to eight parts of soil; but in choosing the latter, use that which has a good mechanical condition, in preference to one full of humus. Half the troubles which arise in growing this crop arise from choosing a too rich soil at the start, and not using sufficient carbonate of lime for their cultivation.

Experience has taught that better and firmer growth and more fruit is produced if some kind of fertiliser is mixed with the soil used for pot, box, or border work, and the following has always given excellent results:—

Sandy Soil.	Chalky Soil.
2 lbs. of sulphate of potash.	2 lbs. of sulphate of potash.
7 lbs. of bone meal.	7 lbs. of superphosphate of lime.
Heavy Soil.	**Peaty Soil.**
1 lb. of sulphate of potash.	2 lbs. of sulphate of potash.
7 lbs. of basic slag.	7 lbs. of basic slag.

The quantities given are sufficient for nine good barrow-loads of soil mixture. In addition to the above, pulverised chalk or powdered limestone should be used at the rate of 7 lbs. per nine barrow-loads, and the soil should be mixed a few weeks before required.

To ensure a continuous supply of well-developed fruit, feed once a week after the first truss has set and the tomatoes are the size of walnuts, with one of the following mixtures:—

Sandy Soil.	Chalky Soil.
2 parts of dried blood.	3 parts of fish guano.
2 parts of nitrate of lime or soda.	4 parts of concentrated superphosphate.
8 parts of superphosphate.	1 part of sulphate of potash.
1 part of sulphate of potash.	
Heavy Soil.	**Peaty Soil.**
2 parts of sulphate of ammonia.	2 parts of nitrate of lime.
4 parts of concentrated superphosphate.	4 parts of bone ash.
1 part of sulphate of potash.	1½ part of sulphate of potash.

The quantity to apply is 1 oz. in 2 gallons of water once a week.

Tomatoes planted out in the natural ground require somewhat different treatment. Before digging the land over apply the following to every six square yards:—one barrow-load of well-decayed dung, ½ lb. of sulphate of potash, 1 lb. of bone-meal, and 3 lbs. of quick-lime, or 6 lbs. pulverised chalk or powdered limestone. Fowl manure could take the place of the

bone-meal and sulphate of potash, used at the rate of 7 lbs. per six square yards. In digging the land, mix the manure and fertiliser intimately with the soil.

The following makes one of the best fertilisers for planted out tomatoes :—2 parts sulphate of ammonia, 4 parts dissolved bones, and 1 part sulphate of potash, applied at the rate of 2 ozs. per square yard, equal to 4 lbs. per square rod, once a fortnight, after the first fruit is set and swelling. If the grower wants a more simple mixture, use either Peruvian guano or best fish meal at the rate given above.

If tomato plants make too much growth and too little fruit, apply bone-ash 2 ozs. per square yard, until they commence to set better, for luxuriant growth is a sign that they have too much nitrogen.

Turnips and Radishes.—Turnips and radishes grow best in a fairly fertile soil, this being better than applying dung before seed sowing. Both crops absorb fairly large quantities of phosphates, and if a fertile piece of land be chosen and, instead of applying dung, one or other of the following fertilisers are used, good roots will be obtained. On clayey or stiff soils, or those full of humus, apply 7 lbs. of basic slag per square rod ; on soil of a sandy or chalky nature use 4 lbs. of dissolved bones over the same area. After sowing the seed, give the soil a dressing of soot, and apply another light dusting as soon as the first rough leaf is seen.

Vegetable Marrows.—It is a mistake to think that vegetable marrows will only grow on a heap of dung. This is about the worst place to put them, unless a good barrow-load of soil is put on the manure for each plant to grow in. Ordinary garden soil will grow excellent crops of marrows if farmyard manure be applied at the rate of one barrow-load to four square yards. A sprinkling of slaked lime should aways be dusted over the land after it is prepared. For feeding purposes nothing seems to be better than an occasional watering with weak liquid manure, and when this cannot be obtained, dried blood or guano, at the rate of 1 oz. per 2 gallons of water, should be used.

The same treatment as above is suitable for gourds and pumpkins.

CHAPTER XII.

Formulae of the Late Dr. Griffiths.

MANY years ago the publishers issued a handbook containing special manure formulæ for greenhouse plants, hardy annuals, half-hardy annuals and biennials, hardy perennials, shrubs, fruit trees, and vegetables. The book has long been out of print and, although frequent enquiries are made for it, the publishers have not deemed it advisable to reprint, partly because the author, the late Dr. A. B. Griffiths, a well-known agricultural and horticultural expert on manures, had embodied a lot of technical matter, which rendered the text too advanced to suit the requirements of the average amateur. As the formulæ section of the book is sound, useful information, it has been decided to include it in an abridged form in the present edition of Mr. Dyke's excellent practical work.

GREENHOUSE PLANTS.

Abutilons.—These valuable perennials require a fairly rich soil, and are greatly benefited by being watered with a solution containing half an ounce each of superphosphate of lime and nitrate of soda.

Acacia Drummondi.—This plant requires a good soil, and should be watered from time to time with a solution containing half an ounce of kainit, a quarter of an ounce each of superphosphate of lime and nitrate of soda, and an eighth of an ounce of iron sulphate to two gallons of water. This liquid manure should be applied at the roots during the blooming season and afterwards—that is, the watering should be continued through the summer. The same liquid manure benefits most of the acacias.

Achimenes.—The plants should be freely watered with a solution containing an eighth of an ounce each of nitrate of soda and kainit to two gallons of water.

Aloes.—These should be occasionally watered with a solution containing a quarter of an ounce of sulphate of ammonia and an eighth of an ounce each of kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Amaryllis should be watered with a solution containing a quarter of an ounce of kainit, half an ounce of super-

phosphate of lime, and an eighth of an ounce each of iron sulphate and nitrate of soda to two gallons of water.

Auriculas.—The seedlings should be watered occasionally with a liquid manure containing a quarter of an ounce of kainit, a quarter of an ounce of nitrate of soda, and half an ounce of superphosphate to two gallons of water.

Azaleas grow best in a compost containing peat; and are greatly benefited by being watered from time to time with a liquid manure containing half an ounce of nitrate of potash and an eighth of an ounce of iron sulphate to two gallons of water. This manure improves the colour and shape of the blooms.

Begonias.—After the young leaves are formed, the plants are benefited by being occasionally watered with a liquid manure containing half an ounce each of nitrate of soda, superphosphate, and kainit to a gallon of water. The same liquid manure benefits begonias raised from tubers.

Bouvardias are winter-flowering plants. They require a rich compost or soil, and are benefited by the addition of soot and bone-meal to the soil—especially during the second and third years of growth. About the end of August or the beginning of September bouvardias should be watered once a week with a solution containing a quarter of an ounce each of sulphate of ammonia and kainit, and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Brunfelsias. — During active growth the plants should be watered with a solution containing an eighth of an ounce each of nitrate of soda and kainit to two gallons of water.

Cacti should be watered with a solution containing half an ounce of silicate of soda, an eighth of an ounce each of superphopsphate of lime, magnesium sulphate, and nitrate of potash to two gallons of water. This liquid manure should be given during the spring and summer, but very sparingly in the winter.

Calceolarias, whether grown in pots or as bedding-out plants, are benefited by being watered with a solution containing a quarter of an ounce each of nitrate of soda, kainit, and superphosphate of lime to two gallons of water.

Camellias.—One of the best liquid manures for the successful cultivation of these plants contains a quarter of an ounce each of nitrate of potash, superphosphate of lime, and iron sulphate to two gallons of water. This manure has the property of increasing the vigour of the plants, improving the colour of the foliage, and entirely preventing the shedding of the buds.

Cannas.—These require a rich soil or compost consisting of leaf-mould, loam, sand, and horse-dung. They are benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia, and an eighth of an ounce each of iron sulphate and superphosphate of lime to two gallons of water. This manure is of value during the period of flowering, and it prevents the leaves from turning yellow.

Celosias require the same liquid manure as cockscombs, namely, a quarter of an ounce each of sulphate of ammonia and kainit to two gallons of water.

Chrysanthemums grow best in a soil composed of leaf-mould, loam, well-rotted dung, and a small quantity of coarse sand. In addition to the above-mentioned constituents, a small quantity of either bone-meal or Peruvian guano greatly improves the quality of the soil for the growth of chrysanthemums. These showy flowers are benefited by being watered with a solution containing half an ounce of sulphate of ammonia, and a quarter of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Cinerarias. — These plants are greatly benefited by watering them with a liquid manure containing a quarter of an ounce each of kainit, nitrate of soda, superphosphate, and sulphate of magnesia to two gallons of water.

Clianthus is a greenhouse and half-hardy climber. The following liquid manure is useful in the culture of this plant: A quarter of an ounce of sulphate of ammonia and an eighth of an ounce of superphosphate of lime to two gallons of water. It is also known as the "Glory Pea of Australia."

Cobæa scandens is a useful climbing plant, and well adapted for the greenhouse. It prefers a sandy soil, and is benefited by being watered with a solution containing an eighth of an ounce each of superphosphate of lime, kainit, and iron sulphate to two gallons of water. This manure strengthens the plants and enhances the colour of the blooms.

Coleus.—The plants should be occasionally watered with a solution containing a quarter of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Cordyline australis is a handsome greenhouse plant; and young plants in pots are most suitable for room decoration. When the plants are fairly established, they are greatly improved by being watered with a solution containing a quarter of an ounce each of kainit, superphosphate of lime, and iron sulphate to two gallons of water. This liquid manure should be given to the plants about twice a month.

Crassulas or Kalosanthes are greenhouse plants, which prefer a compost of sandy loam, brick rubble, sand, and

well-rotted cow dung. They should be occasionally watered with a solution containing an eighth of an ounce each of kainit, iron sulphate, and nitrate of soda to two gallons of water.

Cupheas are benefited by being watered with a solution containing a quarter of an ounce of superphosphate of lime and an eighth of an ounce each of kainit, nitrate of soda, and iron sulphate to two gallons of water.

Cyclamen are improved by being watered near the roots with a liquid manure containing a quarter of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Cyperus is an ornamental foliage plant. It should be watered with a solution containing a fifth of an ounce of iron sulphate to two gallons of water. This solution should not be applied over the foliage. When this plant is grown in pots and used for table decoration it is advisable to keep a few crystals (two or three) of iron sulphate on the surface of the soil in each pot. This treatment keeps the foliage a deep green colour, and prevents chlorosis or the decay of the green colouring matter (chlorophyll) of the leaves.

Diplacus Glutinosus.—A compost of equal parts of leaf-mould and loam suits this plant. It should be watered during the period of active growth (*i.e.*, in the spring and summer) with a solution containing a quarter of an ounce of nitrate of soda and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Echeverias.—These are benefited by being watered from time to time with a solution containing a quarter of an ounce of kainit and an eighth of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water.

Egg Plants bear showy fruits. They should be occasionally watered with a solution containing an eighth of an ounce each of sulphate of ammonia ("grey sulphate," as it is technically termed) and superphosphate of lime to two gallons of water.

Eucomises are greenhouse flowering plants. They are benefited by being watered from time to time with a solution containing an eighth of an ounce each of sulphate of ammonia, superphosphate of lime, and kainit to two gallons of water.

Eupatoriums grow in good ordinary soil. They are greatly benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia and a sixth of an ounce each of nitrate of potash and superphosphate of lime to two gallons of water.

Euphorbia splendens. — This is a climbing greenhouse plant, and it is benefited by being occasionally watered

with a liquid manure containing a quarter of an ounce of nitrate of soda and an eighth of an ounce each of superphosphate of lime, kainit, and iron sulphate to two gallons of water.

Ferns are benefited by being watered from time to time with a solution containing a quarter of an ounce of silicate of soda and an eighth of an ounce each of phosphate of ammonia and kainit to two gallons of water. For ferns grown in rooms, the author always keeps a few crystals (two or three) of iron sulphate on the surface of the soil. This salt undoubtedly keeps the fronds in a fresh green state.

Freesias.—These should be occasionally watered with a solution containing a quarter of an ounce each of nitrate of soda and kainit to two gallons of water. This manure enhances the delicious perfume and the colours of the flowers.

Fuchsias are grown from seed or cuttings. The latter should be planted in pots containing a soil composed of leaf-mould, loam, and sand. The plants should be frequently watered with a liquid manure containing half an ounce each of sulphate of ammonia and kainit to two gallons of water.

Grevillea robusta is a beautiful foliage shrub. It grows well in any good soil of a light nature. It should be watered with a solution containing a quarter of an ounce each of kainit, superphosphate of lime, and nitrate of soda, and an eighth of an ounce of iron sulphate to two gallons of water.

Gazanias are benefited by being watered with a solution containing an eighth of an ounce each of superphosphate of lime, nitrate of soda, kainit, and iron sulphate to two gallons of water.

Gesneras require a rich soil and plenty of water. They are benefited by being watered with a solution containing half an ounce of sulphate of ammonia, a quarter of an ounce of superphosphate of lime, and an eighth of an ounce each of iron sulphate and kainit to two gallons of water.

Gloxinia.—The liquid manure recommended for begonias, or an occasional dose of diluted manure water, will prove beneficial for gloxinias. In applying the liquid manures, care should be taken that the foliage is not wetted, and it must not be forgotten that these manures are to be discontinued during the time of flowering.

Heaths prefer a peaty soil, and are greatly benefited by being occasionally watered with a solution containing a quarter of an ounce of silicate of soda ("water-glass"), and an eighth of an ounce each of superphosphate of lime, iron sulphate, and nitrate of potash to two gallons of water.

Hedychiums.—These prefer a soil composed of two parts of peat and one part of loam and sand. They should be watered from time to time with a solution containing half an ounce of nitrate of potash and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Heliotrope. — This sweely-scented flowering plant is benefited by being watered with a solution containing a quarter of an ounce of nitrate of potash, and an eighth of an ounce of superphosphate of lime to two gallons of water.

Ice Plants (Mesembryanthemums) grow best in a compost containing sandy loam, gypsum, or old mortar, and well-rotted manure. These plants are benefited by being watered with a solution containing half an ounce of kainit, a quarter of an ounce of superphosphate of lime, and an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Impatiens Sultani.—This plant will be benefited by being occasionally watered with a solution containing an eighth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

India-rubber Plants.—These plants should be watered with a solution containing a quarter of an ounce each of nitrate of potash, superphosphate of lime, and iron sulphate to two gallons of water.

Justicias are benefited by being watered with a solution containing an eighth of an ounce of nitrate of potash, superphosphate of lime, and iron sulphate to two gallons of water.

Lantanas are beautiful bedding or pot plants. It appears that blood manures suit these plants better than any other kind of manure. Dried blood contains fifteen per cent. of nitrogen, and the ash contains seventeen per cent. of phosphate of soda, fifty-nine per cent. of chloride of sodium (common salt), six per cent. of chloride of potassium, and eight per cent. of iron oxide.

Lapagerias are greenhouse plants. They should be occasionally watered with a solution containing a quarter of an ounce of nitrate of potash to two gallons of water. A top-dressing of peat, soot, and fine sand greatly benefits these plants.

Loasas.—A liquid manure containing a quarter of an ounce each of sulphate of ammonia and kainit to two gallons of water should be occasionally applied to the plants during the period of flowering.

Lophospermums are handsome half-hardy climbers. They are benefited by being watered with a solution contain-

ing a quarter of an ounce of superphosphate of lime and an eighth of an ounce each of nitrate of soda, kainit, and iron sulphate to two gallons of water.

Manettias are greenhouse evergreen climbers. They should be freely watered with a solution containing an eighth of an ounce each of superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Maurandyas are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of potash and superphosphate of lime to two gallons of water.

Melianthus.—This plant should be watered from time to time with a solution containing an eighth of an ounce each of the sulphates of ammonia, iron, and magnesia to two gallons of water.

Myrtle.—This shrub is benefited by being watered from time to time with a solution containing a quarter of an ounce each of kainit, superphosphate of lime, and nitrate of soda, and an eighth of an ounce of iron sulphate to two gallons of water.

Oleanders (Nerium) are greenhouse shrubs. Oleanders should be watered twice a week, from May to September, with a solution containing a quarter of an ounce of soda and an eighth of an ounce each of superphosphate of lime, kainit, and iron sulphate to two gallons of water.

Oxalis Valdiviana should be occasionally watered with a solution containing a quarter of an ounce of superphosphate of lime and an eighth of an ounce of kainit to two gallons of water.

Palms.—These plants should be carefully watered with a solution containing a quarter of an ounce each of nitrate of soda, iron sulphate, and superphosphate of lime to two gallons of water. In addition to this manure, the author always keeps a few crystals of iron sulphate on the surface of the soil in which palms are growing. These crystals gradually dissolve as the plants are watered from time to time. There is no doubt that iron sulphate is highly beneficial for most foliage plants, and especially for those grown in ordinary dwelling-rooms. Iron sulphate has the property of stimulating the activity of the chlorophyll in most green plants.

Pancratiums should be watered in the summer with a solution containing an eighth of an ounce each of nitrate of potash and superphosphate of lime to two gallons of water.

Passion Flowers (Passifloras). — These should be watered with a solution containing half an ounce of superphosphate of lime, a quarter of an ounce each of kainit and nitrate of soda, and an eighth of an ounce of iron sulphate to

two gallons of water. This manure enhances the colours and shapes of the blooms, besides producing strong, healthy plants.

Pelargoniums require a light soil or compost of loam, leaf-mould, and fine sand, and are benefited by being occasionally watered with a liquid manure containing a quarter of an ounce each of sulphate of ammonia, iron sulphate, and kainit to two gallons of water. This manure not only hastens the growth but improves and beautifies the colour of the blooms, and gives them and the plants a healthy rich appearance. It does this by helping nature in producing plants with the highest state of vitality; consequently, perfect blooms both in colour and shape are the result of the application of this special manure.

Petunias.—When the plants are large enough, it will be found advantageous to water them with a liquid manure containing a quarter of an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water. Frequent applications of this manure increase the size of the flowers, enhance the brightness of the colours, and cause the plants to bloom more freely.

Plumbagos are improved by being watered with a solution containing an eighth of an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water.

Primulas.—When the active period of growth commences —or, in other words, when the plants are beginning to fill the pots with roots—they should frequently be watered with a solution containing a quarter of an ounce each of sulphate of ammonia and kainit to two gallons of water.

Rivina humilis is a beautiful greenhouse plant, producing racemes of white flowers, which are succeeded by small red berries. This plant is benefited by being watered with a solution containing a quarter of an ounce of kainit, and an eighth of an ounce each superphosphate of lime and nitrate of soda to two gallons of water.

Salvias should be watered with a liquid manure containing a quarter of an ounce of superphosphate of lime, and an eighth of an ounce each of nitrate of soda and magnesium sulphate to two gallons of water.

Selaginellas should be watered from time to time with the same manure as recommended for ferns.

Sensitive Plant (Mimosa sensitiva) is improved by being watered with a solution containing an eighth of an ounce each of superphosphate of lime, sulphate of magnesia, and nitrate of soda to two gallons of water.

Smilax is benefited by being watered with a solution containing an eighth of an ounce each of nitrate of potash (saltpetre) and iron sulphate to two gallons of water.

Solanum jasminoides should be watered with a solution containing a quarter of an ounce of potash (saltpetre) and an eighth of an ounce of superphosphate of lime to two gallons of water.

Stephanotis should be occasionally watered with a solution containing an eighth of an ounce each of nitrate of potash and superphosphate of lime to two gallons of water.

Streptocarpus is a greenhouse perennial of a highly decorative character. It should be watered with a solution containing a sixth of an ounce each of sulphate of ammonia, iron sulphate, and superphosphate of lime to two gallons of water.

Streptosolens are benefited by being watered during the summer with a solution containing an eighth of an ounce each of kainit, superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Thunbergias should be watered from time to time with a solution containing a quarter of an ounce of nitrate of potash and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Torenias should be watered from time to time with a solution containing a quarter of an ounce each of kainit and superphosphate of lime, and an eighth of an ounce of nitrate of soda to two gallons of water.

Vallotas are benefited by being watered from time to time with a solution containing an eighth of an ounce each of nitrate of soda, superphosphate of lime, and sulphate of magnesia to two gallons of water.

Verbenas.—These plants (after planting out) are benefited by being watered with a solution containing a quarter of an ounce each of kainit and nitrate of soda, half an ounce of superphosphate of lime, and an eighth of an ounce of iron sulphate to two gallons of water.

Hardy Annuals.

Acrocliniums are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda, superphosphate of lime, and kainit to two gallons of water.

Ammobiums should be watered with a solution containing a sixth of an ounce each of superphosphate of lime, nitrate of soda, and kainit to two gallons of water.

Asters (China).—After transplanting in May, the plants should be dressed with a liberal quantity of well-rotted dung, and watered from time to time with a liquid manure containing half an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water.

Bartonias are benefited by being watered with a solution containing a quarter of an ounce of nitrate of soda, and an eighth of an ounce each of kainit and superphosphate of lime to two gallons of water.

Calandrinias.—Water with a solution containing an eighth of an ounce each of nitrate of soda, kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Callirhoes are hardy annuals, improved by being watered with a solution containing a quarter of an ounce of nitrate of potash, and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Candytuft should be occasionally watered with a solution containing a quarter of an ounce of superphosphate of lime, and one-sixth of an ounce each of kainit and magnesium sulphate to two gallons of water.

Clarkias are benefited by being watered with a liquid manure containing a quarter of an ounce of kainit and half an ounce of superphosphate of lime to two gallons of water. This manure enhances the colours and shape of the blooms.

Collinsias.—These should be watered with a solution containing an eighth of an ounce of sulphate of ammonia and a tenth of an ounce each of superphosphate of lime and kainit to two gallons of water.

Cornflowers (Centaurea cyanus) are benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia and a quarter of an ounce of superphosphate of lime to two gallons of water. This liquid manure must not be applied over the blooms. Cornflowers are also benefited by blood manures, which should be used as top-dressings on the soil.

Daturas.—Water these with a solution containing half an ounce of superphosphate of lime, a quarter of an ounce each of kainit, magnesium sulphate, and nitrate of soda, and one-sixth of an ounce of iron sulphate to two gallons of water. This liquid manure enhances the colour of the blooms.

Erysimums.—Water with a solution containing an eighth of an ounce each of phosphate of ammonia and magnesium sulphate to two gallons of water.

Eschscholtzias are benefited by being watered with a solution containing an eighth of an ounce each of sulphate

of ammonia and superphosphate of lime to two gallons of water. This liquid manure enhances the colour of the blooms and prevents them falling too rapidly; in other words, it increases the vitality of the plants. It may be stated *en passant* that sulphate of ammonia is a better nitrogenous manure to use for eschscholtzias than nitrate of soda.

Eucharidiums.—Water with a solution containing an eighth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Eutocas.—These should be watered with a solution containing a quarter of an ounce of superphosphate of lime to two gallons of water.

Gilias are benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia, and a sixth of an ounce each of kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Godetias are benefited by being watered with a liquid manure containing a quarter of an ounce each of kainit and superphosphate of lime, and one-sixth of an ounce of nitrate of soda to two gallons of water. This manure enhances the brilliancy of the colour of the blooms.

Helichrysums.—Water with a solution containing an eighth of an ounce each of superphosphate of lime, nitrate of soda, and kainit, to two gallons of water.

Hibiscus is a hardy annual. It is benefited by being watered with a solution containing a quarter of an ounce each of nitrate of potash and sulphate of magnesia to two gallons of water.

Jacobæa (Senecio elegans).—This annual is benefited by being watered with a solution containing half an ounce of kainit, a quarter of an ounce each of superphosphate of lime and common salt (sodium chloride), and an eighth of an ounce of iron sulphate to two gallons of water.

Kaulfussias. — These plants are improved by being watered from time to time with a solution containing an eighth of an ounce each of nitrate of potash, superphosphate of lime, and iron sulphate to two gallons of water.

Lavateras are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Layias are annuals of Californian origin, much improved by being watered with a solution containing a quarter of an ounce of nitrate of potash to two gallons of water.

Leptosiphons are benefited by being occasionally watered with a solution containing a quarter of an ounce

each of kainit and superphosphate of lime to two gallons of water.

Leptosynes.—Water with a solution containing an eighth of an ounce each of sulphate of magnesia, iron sulphate, and nitrate of soda to two gallons of water.

Limanthes Douglasi. — This plant is improved by being watered with a solution containing a quarter of an ounce of nitrate of potash and an eighth of an ounce of iron sulphate to two gallons of water.

Linarias. — The beautiful and varied colours of linarias are greatly improved by watering the plants with a solution containing an eighth of an ounce each of nitrate of soda, superphosphate of lime, and iron sulphate to two gallons of water.

Lupines.—These should be watered from time to time with a solution containing half an ounce of superphosphate of lime, a quarter of an ounce of kainit, and half an ounce of nitrate of soda to two gallons of water. This manure may be used during the time of flowering.

Malopes should be watered from time to time with a solution containing an eighth of an ounce aach of nitrate of soda, superphosphate of lime, and iron sulphate to two gallons of water.

Marigolds (Calendula officinalis) are benefited by being watered with a solution containing a quarter of an ounce each of kainit, iron sulphate, superphosphate of lime, and nitrate of soda to two gallons of water.

Mignonette.—It is essential for the production of large heads that frequent applications of liquid manure should be given to this sweet-scented flower. It should be watered with a solution containing half an ounce of nitrate of potash, and a quarter of an ounce each of magnesium sulphate and superphosphate of lime to two gallons of water.

Nasturtiums grow almost in any soil, and flower best in soil of poor quality. A solution containing a quarter of an ounce of kainit to two gallons of water enhances the colours of the blooms. It should only be applied during the period of flowering.

Nemesias.—These are benefited by being watered with a weak solution of nitrate of potash or saltpetre (an eighth of an ounce to two gallons of water). The soil used for raising the seedlings should be mixed with a handful of wood-ashes.

Nemophilas. — Although nemophilas contain a large amount of potash, it is unnecessary to give proportionally large quantities of potash (kainit) to these plants, because they

seem to possess the power of absorbing sufficient quantities of that material even from its less easily soluble chemical combinations in the soil, and from comparatively weak solutions. Nemophilas should be watered with a solution containing a quarter of an ounce each of superphosphate of lime and nitrate of soda, and a sixth of an ounce of kainit to two gallons of water.

Nigellas are improved by being watered with a solution containing a quarter of an ounce of kainit, and a sixth of an ounce each of superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water. These annuals grow in ordinary garden soil, but they are improved when the above-mentioned special manure is used.

Nolanas should be watered from time to time with a solution containing an eighth of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water.

Ornamental Grasses. — Such grasses as Briza minima and B. maxima (quaking grasses), Lagurus ovatus (hare's-tail grass), Poa amabilis, Lasiagrostis argentea, Agrostis pulchella, and Eragrostis elegans (love grass) are most useful for bouquets and vases. They should be watered from time to time with the same manure as recommended for pampas grass.

Phacelias are benefited by being watered with a solution containing a quarter of an ounce of nitrate of soda, and an eighth of an ounce of superphosphate of lime to two gallons of water.

Platystemons are benefited by being watered with a solution containing a sixth of an ounce each of kainit and phosphate of ammonia to two gallons of water.

Poppies.—Most of the perennial and annual poppies are improved by being watered from time to time with a solution containing a quarter of an ounce each of kainit, nitrate of soda, and superphosphate of lime to two gallons of water.

Portulacas are much improved by being occasionally watered with a solution containing an eighth of an ounce each of sulphate of ammonia, kainit, and superphosphate of lime to two gallons of water.

Prince's Feathers are benefited by being watered from time to time with a solution containing a quarter of an ounce of superphosphate of lime, and an eighth of an ounce of sulphate of ammonia to two gallons of water.

Sanvitalias should be watered from time to time with a solution containing a sixth of an ounce each of kainit, nitrate of soda, and superphosphate of lime to two gallons of water.

Saponarias are benefited by being watered with a solution containing a quarter of an ounce each of nitrate of soda, superphosphate of lime, sulphate of magnesia, and iron sulphate to two gallons of water. This liquid manure improves the colours and shapes of the blooms. These hardy annuals require very little potash, consequently the special manure recommended for their growth does not contain potash in the form of kainit. Saponarias, like nemophilas, are able to obtain a sufficient supply of potash from the soil.

Silenes are benefited by being watered with a solution containing a quarter of an ounce of kainit, and an eighth of of an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water.

Sphenogynes are greatly benefited by being watered with a solution containing an eighth of an ounce each of kainit, iron sulphate, and superphosphate of lime to two gallons of water. This solution should not be used during the flowering season.

Stocks require a rich soil, and are benefited by being watered with a solution containing a quarter of an ounce each of kainit, sulphate of magnesia, and superphosphate of lime to two gallons of water. This manure enhances the colour of the blooms.

Sweet Peas flower luxuriantly when grown in good soil with liberal treatment. They should be watered with a solution containing a quarter of an ounce each of kainit and superphosphate of lime, and an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Whitlavias should be watered from time to time with a solution containing an eighth of an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water.

Xeranthemums are benefited by being watered with a solution containing a quarter of an ounce of kainit, and an eighth of an ounce each of superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Half-Hardy Annuals and Biennials.

Abronias are benefited by being watered with a solution containing a sixth of an ounce each of superphosphate of lime, kainit, and nitrate of soda to two gallons of water.

Ageratums are benefited during the flowering season by being occasionally watered with a solution containing an eighth of an ounce each of nitrate of potash, superphosphate of lime, and iron sulphate to two gallons of water.

Alonsoas require only a small amount of artificial manure, as they are capable of extracting the mineral matter which they require from ordinary soil. Nevertheless, they are benefited by being occasionally watered with a solution containing an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Amaranthus.—The varieties of this plant are benefited by being watered with a solution containing an eighth of an ounce each of sulphate of magnesia, nitrate of soda, and superphosphate of lime to two gallons of water.

Balsams and Cockscombs should be watered with a liquid manure containing a quarter of an ounce each of sulphate of ammonia and kainit to two gallons of water.

Brachycomes, or Swan River daisies, are benefited by being watered with a solution containing a sixth of an ounce each of sulphate of magnesia, superphosphate of lime, and sulphate of ammonia to two gallons of water.

Browallias are benefited by being watered with a solution containing a sixth of an ounce each of nitrate of soda, kainit, and superphosphate of lime to two gallons of water.

Clintonias.—Water with a solution containing a quarter of an ounce of nitrate of potash, and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Dianthus (Japanese Pinks).—These half-hardy biennials are benefited during active growth by being watered with a solution containing half an ounce of kainit, an eighth of an ounce of iron sulphate, and a quarter of an ounce of superphosphate of lime to two gallons of water.

Exacums should be watered from time to time with a solution containing a fifth of an ounce each of nitrate of soda, kainit, iron sulphate, and superphosphate of lime to two gallons of water. This liquid manure enhances the perfume and colour of the blooms.

Grammanthes, a beautiful half-hardy annual, is greatly benefited by being watered from time to time with a solution containing an eighth of an ounce each of nitrate of potash and superphosphate of lime to two gallons of water.

Helipterums.—A liquid manure which suits them contains an eigth of an ounce each of kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Japanese Maize should be frequently watered with a solution containing a quarter of an ounce of sulphate of ammonia, and an eighth of an ounce each of kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Lobelias are greatly benefited by being watered with a solution containing a quarter of an ounce of superphosphate of lime and an eighth of an ounce each of kainit and nitrate of soda to two gallons of water.

Martynias are benefited by being watered with a solution containing a quarter of an ounce of superphosphate of lime and an eighth of an ounce each of kainit, nitrate of soda, and iron sulphate to two gallons of water.

Mimulus.—Musk should be watered from time to time with a solution containing a quarter of an ounce of kainit, and an eighth of an ounce each of sulphate of ammonia and superphosphate of lime to two gallons of water.

Minas should be watered with a solution containing an eighth of an ounce each of nitrate of soda, iron sulphate, superphosphate of lime, and kainit (sulphates of potash and magnesia) to two gallons of water. This manure enhances the shapes of the flowers.

Nycterinias are benefited by being occasionally watered with a solution containing an eighth of an ounce each of superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Perillas should be watered with a solution containing a quarter of an ounce each of nitrate of potash and superphosphate to two gallons of water.

Rhodanthes are benefited by being watered with a solution containing a sixth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water. This liquid manure greatly enhances the colours of these beautiful and elegant everlasting flowers.

Salpiglossis. — The most suitable liquid manure for salpiglossis contains a quarter of an ounce each of kainit, superphosphate of lime, and nitrate of soda to two gallons of water. This manure enhances the colours and shapes of the blooms.

Schizanthus.—The various varieties of this half-hardy annual are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of potash and iron sulphate (green vitriol or copperas) to two gallons of water.

Scyphanthus should be watered with a solution containing a quarter of an ounce of nitrate of soda and a sixth of an ounce each of superphosphate of lime and sulphate of magnesia to two gallons of water.

Stevias are benefited by being watered with a solution

containing a quarter of an ounce of nitrate of soda and an eighth of an ounce of iron sulphate to two gallons of water.

Tagetes (French and African Marigolds) are benefited by being watered with a solution containing a quarter of an ounce of kainit and an eighth of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water.

Tobacco Plants.—After transplanting the seedlings, the young plants should be watered from time to time with a solution containing half an ounce of nitrate of potash (saltpetre) and a quarter of an ounce of superphosphate of lime to two gallons of water. This liquid manure is of great value in aiding the growth of these ornamental plants.

Waitzia grandiflora is benefited by being watered with a solution containing an eighth of an ounce each of nitrate of potash (saltpetre), sulphate of magnesia, and superphosphate of lime to two gallons of water.

Zinnias.—After transplanting and hardening the young plants, they should be watered from time to time with a liquid manure containing half an ounce of sulphate of ammonia and superphosphate of lime to two gallons of water.

BIENNIALS.

Celsia cretica is benefited by being watered with a solution containing a quarter of an ounce of nitrate of potash and a sixth of an ounce of superphosphate of lime to two gallons of water.

Foxgloves (Digitalis) are biennials. The liquid manure recommended for snapdragons will also benefit foxgloves.

Honesty (Lunaria biennis) is benefited by being occasionally watered with a solution containing a quarter of an ounce of kainit, and a sixth of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water. The soil for the growth of honesty should be fairly rich.

Wallflowers. — The seeds of these deliciously-scented flowers should be sown on rather poor soil, but after transplanting the young plants are greatly benefited by being watered with a solution containing a quarter of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water.

PERENNIALS.

Agrostemmas (or Campions) are improved by being watered with a solution containing a quarter of an ounce of nitrate of potash to two gallons of water.

Alstromerias are benefited by being watered with a

solution containing a quarter of an ounce of nitrate of potash (saltpetre) to two gallons of water.

Alyssums.—Water with a solution containing an eighth of an ounce each of kainit, iron sulphate, and superphosphate of lime to two gallons of water.

Anagallis.—Water from time to time with a solution containing a sixth of an ounce each of kainit, superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Anchusas are benefited by being watered with a solution containing a quarter of an ounce of kainit and an eighth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Anemone.—The special manure recommended for ranunculus is also applicable for the growth of anemones.

Antirrhinums (or Snapdragons) are benefited by being watered with a solution containing a quarter of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Aquilegias (Columbines).—These are benefited by being watered with a solution containing a quarter of an ounce each of superphosphate of lime and kainit, and an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Aubrietias are improved by being watered with a solution containing an eighth of an ounce each of sulphate of ammonia and iron sulphate to two gallons of water.

Campanulas water with a solution containing a quarter of an ounce each of superphosphate of lime, sulphate of ammonia, and iron sulphate to two gallons of water.

Carnations, Pinks, and Picotees. — Frequent waterings are necessary during dry weather, and the plants are greatly benefited by occasional applications of a liquid manure containing half an ounce of sulphate of ammonia and a quarter of an ounce of kainit to two gallons of water.

Catananches should be watered with a solution containing a quarter of an ounce of kainit, and an eighth of an ounce each of superphosphate of lime and nitrate of soda to two gallons of water.

Centranthus is improved by being watered with a solution containing a quarter of an ounce of superphosphate of lime and an eighth of an ounce of nitrate of soda (Chili saltpetre) to two gallons of water.

Chelones are much improved by being watered with a solution containing a sixth of an ounce each of nitrate of soda,

iron sulphate, sulphate of magnesia, and superphosphate of lime to two gallons of water.

Commelinas are benefited by being watered with a solution containing a sixth of an ounce each of sulphate of ammonia, kainit, and superphosphate of lime to two gallons of water.

Crucianellas are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda and kainit to two gallons of water.

Dahlias.—Frequent waterings, occasionally with liquid manure, or with a solution containing half an ounce of nitrate of soda, a quarter of an ounce of superphosphate, and an eighth of an ounce of iron sulphate to a gallon of water should be given to dahlias until the beginning of August, when the flower buds will appear. A good mulching of well-rotted dung is most useful at this stage of their growth, but the liquid manures should not be given during the time of flowering.

Delphiniums.—The perennial larkspurs are benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia, and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Dodecatheons should be watered with a solution containing a quarter of an ounce of phosphate of potash to two gallons of water. When applied to the handsome crimson variety, this manure greatly enhances the colour and shape of the blooms.

Eremurus robustus is benefited by being watered with a solution containing a quarter of an ounce each of sulphate of ammonia, kainit, magnesium sulphate, and superphosphate of lime to two gallons of water.

Fraxinellas should be watered with a solution containing an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Gaillardias are greatly benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda, superphosphate of lime, and iron sulphate to two gallons of water.

Galtonias should be watered from time to time with a solution containing a sixth of an ounce each of sulphate of ammonia, iron sulphate, and superphosphate of lime to two gallons of water.

Gauras are improved by being watered with a solution containing an eighth of an ounce each of silicate of soda, iron sulphate, and nitrate of potash to two gallons of water.

Gentiana acaulis is a hardy perennial, most suitable for edgings. It prefers a moist soil, and should be provided with surface nourishment, as it has a tendency to produce long roots, which penetrate into the lower strata of the soil in search for food, and consequently only produces flowers in a meagre manner. But this unnecessary growth of roots is remedied by watering with a solution containing a quarter of an ounce of nitrate of soda, and an eighth of an ounce each of superphosphate of lime, iron sulphate, and kainit to two gallons of water.

Geraniums should be watered with the liquid manure recommended for the growth of pelargoniums.

Geums are benefited by being watered with a solution containing a quarter of an ounce each of kainit and nitrate of soda, and a sixth of an ounce of superphosphate of lime to two gallons of water.

Gladiolus.—The special manure recommended for the growth of narcissus is also of value for gladiolus. One ounce of the mixture should be dissolved in two gallons of water, and the plants watered with the solution.

Gypsophilas.—Water with a solution containing an eighth of an ounce each of nitrate of soda, sulphate of magnesia, superphosphate of lime, and iron sulphate to two gallons of water. This manure greatly improves the colours and shapes of the blooms.

Hollyhocks.—Hollyhocks are greatly benefited during the early stages of growth and afterwards by liberal treatment in the form of liquid manure, and the liquid manure recommended contains half an ounce of nitrate of soda and a quarter of an ounce each of kainit, superphosphate, and iron sulphate to two gallons of water. It strengthens the plants and enhances the colour of the blooms, besides protecting the plants against the attacks of the destructive hollyhock fungus.

Iberis should be watered with a solution containing a quarter of an ounce of ammonia and an eighth of an ounce of superphosphate of lime to two gallons of water.

Irises.—These hardy flowers should be occasionally watered with a solution containing a quarter of an ounce each of nitrate of soda, superphosphate of lime, and magnesium sulphate to two gallons of water. This liquid manure should be applied during active growth, but discontinued as soon as the flower buds appear.

Leopard's Banes (Doronicums) are benefited by being watered with a solution containing a quarter of an ounce of nitrate of soda, and an eighth of an ounce each of superphos-

phate of lime, iron sulphate, and kainit to two gallons of water.

Lilies grow best in a rich warm soil or compost, and they are greatly benefited by being occasionally watered with a solution containing a quarter of an ounce of nitrate of soda and half an ounce of superphosphate to two gallons of water.

Lychnis.—The following liquid manure is suitable for the varieties of lychnis: Half an ounce of nitrate of potash and an eighth of an ounce of superphosphate of lime to two gallons of water.

Malvas are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda, superphosphate of lime, and iron sulphate to two gallons of water.

Matricarias should be watered from time to time with a solution containing an eighth of an ounce each of kainit, superphosphate of lime, nitrate of soda, and iron sulphate to two gallons of water.

Milla biflora is a bulbous plant, which produces beautiful white blooms, and is benefited by being watered with a solution containing an eighth of an ounce each of sulphate of ammonia and magnesium sulphate to two gallons of water.

Montbretias. — The plants should be watered with a solution containing a quarter of an ounce of nitrate of soda and an eighth of an ounce each of kainit and iron sulphate to two gallons of water.

Myosotis (Forget-me-not).—This plant is improved by being occasionally watered with a solution containing a quarter of an ounce of nitrate of potash (saltpetre) to two gallons of water.

Narcissus and other Bulbous Plants.—The following special manure is of value for narcissi, hyacinths, tulips, and other bulbous plants: One part by weight of kainit, two parts of mineral phosphate, half a part of nitrate of soda, and a quarter of a part of iron sulphate. For large growers four or five hundredweights per acre of this manure should be spread on the surface of the soil immediately after planting the bulbs. For amateurs and others an ounce of the special manure should be placed in each pot or on the surface of the soil above each bulb. This manure not only improves the blooms, but it prevents the development of the narcissus bulb-rot and the attacks of the narcissus fly. In other words, it strengthens the bulbs, produces healthy plants and fine blooms; and there is little doubt that it is the most suitable

of special manures for the growth of bulbous plants in the majority of British soils.

Nierembergias are improved by being watered from time to time with a solution containing a quarter of an ounce of sulphate of ammonia and an eighth of an ounce of superphosphate of lime to two gallons of water.

Œnotheras (Evening Primroses) are benefited by being watered with a solution containing an eighth of an ounce each of sulphate of ammonia, superphosphate of lime, kainit, and iron sulphate to two gallons of water. This manure should be frequently applied during the period of active growth, but not during the flowering season.

Pæonies are general favourites. A liquid manure containing half an ounce of sulphate of ammonia, a quarter of an ounce of superphosphate of lime, a quarter of an ounce of kainit, and an eighth of an ounce of iron sulphate to two gallons of water, is of great value for the growth of these showy and hardy plants.

Pampas Grass (Gynerium argenteum) should be watered from time to time with a solution containing half an ounce of kainit, a quarter of an ounce each of superphosphate of lime and nitrate of soda, and an eighth of an ounce of iron sulphate to two gallons of water.

Pansies and Violas are benefited by being watered with a liquid manure containing a quarter of an ounce each of sulphate of ammonia, superphosphate, and iron sulphate to two gallons of water. This manure greatly enhances the blooms, and prevents the development of the well-known pansy disease.

Pentstemons are benefited by being watered with a liquid manure containing an eighth of an ounce each of superphosphate of lime, kainit, and sulphate of ammonia to two gallons of water.

Potentillas should be watered from time to time with a solution containing an eighth of an ounce each of superphosphate of lime, iron sulphate, and sulphate of ammonia to two gallons of water.

Pyrethrums are greatly improved by being watered once or twice a week in the summer with a solution containing a quarter of an ounce of sulphate of ammonia and an eighth of an ounce each of superphosphate of lime, kainit, and iron sulphate to two gallons of water.

Ranunculus grows best in moist soils. In the spring the beds should be watered once a week with a special manure, containing a quarter of an ounce each of nitrate of soda, superphosphate, and iron sulphate to a gallon of water. This

liquid manure should be discontinued when the flower buds appear, but the plants during this period of growth require water daily.

Scabious is benefited by being occasionally watered with a solution containing a sixth of an ounce each of nitrate of soda (Chili saltpetre) and sulphate of magnesia to two gallons of water.

Sedums are benefited by being watered from time to time with a solution containing a quarter of an ounce of kainit and half an ounce of superphosphate of lime to two gallons of water. Calcareous soils suit sedums better than any other kind.

Spiræas require a rich soil, and should be watered with a solution containing a quarter of an ounce each of nitrate of soda, superphosphate of lime, and iron sulphate to two gallons of water.

Statices are benefited by being watered with a solution containing an eighth of an ounce each of superphosphate of lime, iron sulphate, and nitrate of soda to two gallons of water.

Sunflowers.—Liberal manuring is essential to ensure fine and well-shaped heads. They are benefited by being watered with a solution containing one ounce of superphosphate of lime, half an ounce of kainit, and a quarter of an ounce of sulphate of ammonia to two gallons of water.

Sweet Williams are benefited by being watered with a solution containing a quarter of an ounce of nitrate of potash, and one-sixth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water.

Thalictrums.—These prefer a rich soil, and should be watered with a solution containing a quarter of an ounce each of kainit, superphosphate of lime, and sulphate of ammonia, and a sixth of an ounce of iron sulphate to two gallons of water.

Veronicas are benefited by being watered with a solution containing a quarter of an ounce each of kainit and superphosphate of lime, and an eighth of an ounce each of nitrate of soda and iron sulphate to two gallons of water.

Violets are benefited by being watered with the same manure as that recommended for pansies.

Yuccas are benefited by using a mixed manure containing one part each by weight of sulphate of ammonia, iron sulphate, and kainit, and two parts of superphosphate of lime. To use this special manure, excavations should be made extending about a yard and a half round the trunk of each tree, and the manure should then be strewn in the excavations. Small

yuccas require from four to six ounces each, whilst larger ones require from eight to ten ounces each of the manure. This treatment should be annually applied in the spring.

Zephyranthes candida. — During the flowering season the plants should be watered with a solution containing a quarter of an ounce of phosphate of ammonia to two gallons of water.

SHRUBS.

Ampelopsis.—The small-leaved creeper, A. Veitchi, is improved by being watered with a solution containing a quarter of an ounce of superphosphate of lime, and an eighth of an ounce each of iron sulphate and nitrate of potash to two gallons of water.

Berberis (or barberry).—This plant grows in ordinary soil, but is much improved by being watered with a liquid manure composed of an eighth of an ounce each of sulphate of ammonia, iron sulphate, and kainit to two gallons of water.

Clematises are benefited by being watered with a solution containing a quarter of an ounce each of nitrate of soda, superphosphate of lime, and kainit, and an eighth of an ounce of iron sulphate to two gallons of water. This liquid manure should be used once a week during the period of active growth and the flowering season.

Daphne Blagayana is an alpine shrub, benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia, and an eighth of an ounce each of superphosphate of lime and iron sulphate to two gallons of water. This liquid manure prevents premature decay.

Genista.—This flowering shrub also contains 6.4 per cent. of albuminoids or nitrogenous constituents. It is benefited by being watered with a solution containing half an ounce of kainit, a quarter of an ounce of superphosphate of lime, half an ounce of nitrate of soda, and a quarter of an ounce of magnesium sulphate to two gallons of water.

Honeysuckles are benefited by mulching the soil for several feet round their bases with well-rotted dung. They should be occasionally watered with a solution containing a quarter of an ounce each of sulphate of ammonia, kainit, and superphosphate of lime, and an eighth of an ounce of iron sulphate to two gallons of water.

Hydrangeas require a rich soil or compost, and they should be watered with a solution containing a quarter of an ounce each of kainit, superphosphate of lime, and sulphate of ammonia, and an eighth of an ounce of iron sulphate to two gallons of water.

Jessamines should be occasionally watered with a solution containing a quarter of an ounce of nitrate of soda, and an eighth of an ounce each of sulphate of magnesia, superphosphate of lime, and iron sulphate to two gallons of water.

Magnolias require a rich soil of a loamy nature, and are benefited by being watered with a solution containing a quarter of an ounce of sulphate of ammonia and an eighth of an ounce each of kainit, iron sulphate, and superphosphate of lime to two gallons of water.

Rhododendrons. — The majority of these flowering shrubs prefer a peaty soil or a soil of a heavy nature. Calcareous soils, or those containing much lime, are detrimental to the growth of rhododendrons. They should be watered from time to time with a solution containing half an ounce of nitrate of soda, a quarter of an ounce of kainit, and an eighth of an ounce of iron sulphate to two gallons of water.

Rock Roses (Cistus).—These shrubby plants should be watered from time to time with a solution containing a quarter of an ounce each of nitrate of soda, kainit, superphosphate of lime, and iron sulphate to two gallons of water.

Roses do best in a stiff loam, which should be top-dressed from time to time with cow-dung. If the season is dry or the soil light, the surface should be mulched with horse-dung. Rose trees are greatly benefited by being watered with a solution containing half an ounce of superphosphate of lime and a quarter of an ounce each of iron sulphate and sulphate of ammonia to two gallons of water.

Southernwood (Artemisia Abrotanum) should be occasionally watered with a solution containing a quarter of an ounce each of sodium silicate and sulphate of magnesia to two gallons of water.

Sun Roses (Helianthemums) are benefited by being watered with a solution containing an eighth of an ounce each of nitrate of soda and superphosphate of lime to two gallons of water.

Virginian Creeper.—This plant also contains 2.96 per cent. of albuminoids or nitrogenous constituents. It is benefited by being watered from time to time with a solution containing half an ounce each of kainit, superphosphate of lime, and nitrate of soda, and an eighth of an ounce of iron sulphate to two gallons of water.

Fruit Trees, Etc.

Apples.—The soil must not be too richly manured with farmyard manure or a rich compost; but apple trees are frequently benefited by using a special manure containing

equal parts by weight of kainit, sulphate of soda (Glauber's salt), and superphosphate. Six pounds of the mixture should be applied to each tree after pruning.

Apricots and Peaches.—After grapes, apricots and peaches remove more mineral matter from the soil than any other fruit grown in this country. As a rule, apricot and peach trees grow best in good medium soils, but the subsoil must not be too rich, and it is better if it is of a clayey nature. One of the largest growers of apricots and peaches in America recommends a special manure composed of one part (by weight) of crude magnesium sulphate, six parts of muriate of potash, and eighteen parts of bone superphosphate. This mixture to be applied at the rate of seven pounds around each tree. A mixture of salt and soot also benefits apricot, peach, and nectarine trees.

Cherries.—The ash of the cherries is rich in potash, lime, and phosphoric acid; and red and white cherries each contain about 2 per cent., and black cherries about 2½ per cent. of nitrogenous substances. Cherry trees are benefited by a special manure containing three parts by weight of kainit, two parts of superphosphate, and one part of nitrate of soda. Three pounds of the mixture should be applied to each tree a little time before active growth begins If the land is deficient in lime or chalk, some must be added for the growth of cherries. It is really surprising to see cherry trees which have not borne fruit for years become most productive after a dressing of lime.

Currants.—Red, white, and black currant trees are also benefited by using the same liquid manure as that described for gooseberries.

Gooseberries. — Gooseberry bushes prefer light and porous soils, and they should be dressed from time to time with well-rotted dung. The bushes are benefited by watering them with a liquid manure containing one ounce of nitrate of soda, half an ounce of iron sulphate, and half an ounce of superphosphate to a gallon of water.

Melons require a good soil, and a turfy loam inclining to a clayey nature is by far the best for the successful growth of this delicious fruit. A good compost is made by mixing equal proportions of loam and well-rotted cow-dung, and this should be the composition of the fruiting-beds. A liquid manure containing half an ounce of sulphate of ammonia and one ounce of superphosphate to a gallon of water is of special value for watering the plants, as it aids considerably in producing strong, healthy, and vigorous plants.

Nuts.—The filberts and cob-nuts, as well as the walnut, are greatly benefited by dressing the land where they grow with lime, phosphates, and potash; one pound of each manure to be placed round each tree.

Pears.—As a general rule, manure should be applied to most fruit trees during the period of active growth in the liquid form. Nitrogenous manures are requisite for backward, but potash and phosphates for forward trees, as the former class of manures aids the growth of the trees, while the latter develops the bloom, the sugar in the fruit, and the ripening of the wood. Pear trees are benefited by using a manure containing four parts by weight of kainit and one part of superphosphate. Four pounds of the mixture should be applied to each tree after pruning. If the trees are at all backward, they should be watered once a week with a solution containing one ounce of nitrate of soda to two gallons of water.

Plums.—These trees should be treated from time to time with cow-dung, and a mixed manure composed of five parts of kainit, one part of magnesium sulphate, and two parts of superphosphate, is of special value for the growth of these fruit trees. Seven pounds of the mixture should be applied to each tree after pruning, and an additional two pounds in the spring. Plum trees so treated will often bear fruit even in a bad plum season.

Raspberries. — Raspberry canes prefer a light soil, which should have been deeply dug and well manured in the first instance. The soil should also receive an annual dressing of manure. Under high cultivation a special manure containing two parts by weight of nitrate of soda, one part of superphosphate and one part of kainit gave excellent results. Two pounds of the manure should be used for dressing a hundred canes.

Strawberries are benefited by the use of potash manures, which not only increase the yield, but also the quality of the fruit.

Vines.—A good special manure for vines contains seven parts by weight of superphosphate, six parts of kainit, two parts of magnesium sulphate, and three parts of nitrate of soda. This manure should be applied in doses of half a pound to each vine.

VEGETABLES, ETC.

Asparagus requires a richly-manured soil, which should be prepared in the autumn, dung being worked in with a small quantity of salt and soot. When established apply a solution

containing one ounce of sulphate of ammonia, two ounces of superphosphate, and one ounce of kainit to a gallon of water. This liquid manure has special advantages in dry weather, and it may be used for watering the young plants grown from seed before they are transplanted.

Beans are also benefited by the same mixed manure as peas; but in addition to the three typical ingredients contained in pea manure, one pound of iron sulphate per square rod (30¼ square yards) should be used for the growth of beans. It should be borne in mind that the ingredients of many of the artificial manures act and react on the soil; and it is by this means that several of the insoluble and minor constituents of the soil are rendered soluble, and hence they become direct plant foods. Judiciously used, mixed manures are the agents which bring into useful activity the latent constituents of the soil; moreover, they restore the proper equilibrium between its different constituents, and supply the excessive demand for some particular element or elements.

Beetroots.—As the seed is generally sown in May, it is essential for the proper growth of this garden crop that the manuring of the soil should be principally done during the previous year; but in the month of March the following special manure should be applied to the soil: Two pounds of superphosphate, one pound of guano, half a pound of sulphate of ammonia, and half a pound of kainit per square rod. It will be observed that the manuring is performed before the seed is sown. After thinning, the young plants should be watered with a solution containing one ounce of iron sulphate to a gallon of water.

Cabbage and allied plants. The best manurial mixtures for these crops are the following:—

	Cabbage.	Brussels Sprouts.	Broccoli.	Cauli-flowers.	Spinach
	lbs.	lbs.	lbs.	lbs.	lbs.
Kainit	2½	2½	2	2½	1¼
Sulphate of soda	1	1	1½	1½	1½
Sulphate of ammonia	1½	1½	1½	2	1½
Superphosphate	2½	2	2	2½	2

The above quantities to be applied per square rod. Most of these crops require lime, but as it is an ingredient in superphosphate it need not be applied separately, unless the soil is very deficient in that constituent, when a small quantity of lime proves beneficial. The above mixed manures should be applied after transplanting or thinning. All the cabbage tribe of plants are benefited by watering them from time to time

with a solution containing one ounce of iron sulphate and two ounces of sulphate of ammonia to a gallon of water.

Carrots.—For the growth of carrots the soil should have been manured in the previous autumn with well-rotted dung, as the soil at the time of sowing should be free from any recent manuring with dung. The special manure recommended for parsnips is also applicable for the growth of carrots, and it should be applied at the time of sowing the seed.

Celery.—The finest celery is grown by making what may be called a tri-stratified trench; that is to say, the bottom layer contains fresh horse-manure, the next well-rotted manure, and the top layer soil. The celery is planted in the top layer, the roots of which gradually find their way down into the manures below. Market gardeners and others are frequently recommended to give celery a fair supply of liquid manure. Now a good liquid manure is composed of the following ingredients: Two ounces of kainit, one ounce of sulphate of ammonia, and one ounce of superphosphate per gallon of water. The important point in the proper cultivation of celery is to ensure a continuous growth, hence the value of the liquid manure prescribed. By frequent waterings with liquid manure the amateur gardener aids nature in producing sweet crisp sticks, which possess the fine nutty flavour so characteristic of well-grown celery.

Cucumbers.—The following liquid manure is of special advantage for the growth of cucumbers: One ounce of sulphate of ammonia and one ounce of superphosphate to a gallon of water. At bearing time frequent applications of this liquid manure should be given, as it has proved highly beneficial. It not only supplies nitrogen and phosphoric acid, but reacts upon the soil, rendering soluble certain latent constituents which are also beneficial for the proper growth of this crop.

Endive prefers a light rich soil, and the same liquid manure as recommended for lettuce should se used for the growth of endive. The liquid manure to be applied after thinning out the young plants. This treatment ensures a beautiful growth, and aids considerably in keeping the plants in a fine condition with crisp hearts.

Globe Artichoke (Cynaria scolymus) is a plant which requires a good, deep, somewhat moist, sandy soil. The following liquid manure is specially recommended for the growth of globe artichokes: Two ounces of sulphate of ammonia and one ounce of superphosphate to a gallon of water. The plants should be watered with this liquid manure, especially in dry weather, as it enhances the flavour and the size of the heads.

Herbs, Etc.—Besides the ordinary growth of vegetables and fruit, there are many things in a country garden to be turned to good account, such as the various herbs, etc. Mint, marjoram, sage, thyme, fennel (used in fish sauce and for garnishing), savory, coriander, burnet, dill (leaves used in pickles and sauces), hyssop, etc., are readily grown in good garden soil. The majority of the comomn garden herbs grow much better if they are supplied from time to time with a liquid manure containing one ounce of superphosphate, half an ounce of nitrate of soda, and a quarter of an ounce of iron sulphate to a gallon of water. This manure has also the effect of increasing to a certain extent the intensity of the flavouring and odoriferous principles which these plants manufacture within their tissues.

Jerusalem Artichoke (Helianthus tuberosum).—For the growth of this the soil should have been previously dressed with ordinary farmyard dung. When the young plants are above ground the following special manure may be distributed and then hoed in: Three pounds of kainit, two pounds of nitrate of soda, half a pound of iron sulphate, and seven pounds of superphosphate per square rod. Under such treatment the white variety is more prolific than the purple variety. The above-mentioned special manure also enhances the flavour of the tuber.

Kohl Rabi is a valuable substitute for turnips on soils where the latter are somewhat difficult to cultivate. It is much hardier than turnips, and suffers less from drought. Kohl rabi is a gross feeder, and consequently it requires a liberal supply of both dung and special manures. The soil should have previously received a dressing of dung, and at the time of sowing the seed the following special manure should be applied: Two pounds of superphosphates, two and a-half pounds of guano, three ounces of sulphate of ammonia, and half a pound of kainit per square rod. After transplanting the plants should be watered from time to time with a solution containing one ounce of iron sulphate per gallon of water. This solution promotes a continuous and rapid growth.

Lettuce prefers a light rich soil, and manure must be liberally used for its proper culture. After transplanting, the plants should be frequently watered with a solution containing half an ounce of kainit, one ounce of sulphate of ammonia, half an ounce of superphosphate, and one ounce of silicate of soda to a gallon of water.

Mushrooms.—The cultivation of fungi in this country for esculent purposes is confined to the well-known mushroom. For the growth of mushrooms very little trouble and care is

required, and moderate success is certain. The requirements are horse manure, a small quantity of soil, and good spawn. About six weeks' time the mushrooms should begin to appear, and if the bed is getting dry it is advisable to water it with a warm solution containing a quarter of an ounce of nitrate of potash (saltpetre) to a gallon of water. This mode of treatment brings out the flavour much better than when warm water is used.

Onions and Leeks. — A deep rich soil, previously treated with well-rotted manure, is most suitable for the growth of onions. The soil should be prepared in the autumn or winter by being deeply dug, and rotted manure worked in at the same time. It will then be ready for sowing in the following spring. The mixed manure suitable for the growth of onions is the following: One pound of nitrate of soda, quarter of a pound of guano, three ounces of kainit, and three ounces of iron sulphate per square rod. This quantity should be divided into two equal portions, one of which should be applied as a top-dressing when the plants are a few inches above ground, and the other about four weeks later. A dressing of lime and soot frequently proves beneficial. For the growth of leeks the land should have been previously treated with well-rotted manure. Leeks are greatly benefited by frequent waterings with a solution containing one ounce of kainit, one ounce of superphosphate, and one ounce of nitrate of soda per gallon of water.

Parsley is often benefited by dustings of soot round the plants, followed by waterings with soapsuds. This treatment frequently prevents the ravages of insect pests which feed upon the roots, and consequently injure the plants. Watering parsley with a solution containing half an ounce of sulphate of ammonia and half an ounce of iron sulphate to a gallon of water often causes it to grow both rapidly and luxuriantly.

Parsnips.—These roots require a deep rich soil. The soil should be deeply tilled in the autumn, and left rough during the winter. The following manurial mixture should be applied to the soil at the time of sowing: Two and three-quarter pounds of kainit, one pound of sulphate of ammonia, and two and a-half pounds of guano per square rod. Lime and sulphates need not be applied separately, as they are present in guano and sulphate of ammonia. Manures must not be applied to parsnips on the surface, as they induce lateral or side growths on the roots, which are anything but pleasing to the eye. A dressing of soot may, however, be applied after the young plants have made their appearance.

Peas.—A good manure to use for the successful growth of this crop should contain the following ingredients: Two pounds of kainit, five pounds of nitrate of soda, and nine pounds of superphosphate per square rod. This mixture should only be used as a top-dressing when the young plants are above ground. Peas grow best in good clay soil, sown without dung; that is, if the soil has been manured the previous year. On light dry soils it is always advisable to make deep trenches in which a rather heavy dressing of dung is put, with only a few inches of soil on the top to receive the seed.

Saladings.—The home of the best salads is certainly France; but there is no reason why the various plants which are used at different seasons in French salads should not be grown in this country for the same purpose; consequently the following remarks may be useful to our readers: (1) Rampion is a root of a sweet nut-like flavour, and is used in salads. The leaves are also used in salads. After thinning, water the plants with a solution containing half an ounce of kainit, one ounce of sulphate of ammonia, and one ounce of superphosphate to a gallon of water. This treatment greatly develops the aromatic or nut-like flavour. (2) Chervil is held in great esteem for salads, but the leaves must be used when young and tender, in which condition they have an aromatic and pleasant taste. This aromatic taste is due to the presence of an essentiol oil, which becomes oxydised as the leaves arrive at maturity. The plants are benefited by watering them with a solution containing one ounce of kainit, half an ounce of sulphate of ammonia, and half an ounce of sulphate of magnesia to a gallon of water. The curled variety grows like parsley, and is also useful for garnishing and for flavouring soups. (3) Chicory comprises the so-called "Christmas salad," barbe de capucin, and witloof. After thinning, water the plants occasionally with a solution containing one ounce of sulphate of ammonia, and one and a-half ounces of kainit to a gallon of water. The leaves furnish a delicious addition to any salad.

Potatoes. — This vegetable contains a considerable amount of potash, iron oxide, phosphoric acid, and nitrogen. It is well-known that this particular crop is greatly benefited by applying these ingredients in the form of a mixed manure to the soil, and one of the best manures for this purpose contains three and a-half pounds of kainit, three and a-half pounds of nitrate of soda, one pound of iron sulphate, and seven pounds of superphosphate per square rod. If the soil has been previously dressed with farmyard dung, the mixed

manure should be distributed and then hoed in. If, however, no dung has been used, seven pounds of superphosphate per square rod should be sown in the drills just before planting, and as soon as the young plants are above ground the remaining portion of the manure should be distributed, and then hoed in. Although potatoes require liberal manuring, it must not be overdone. Potash manures (like kainit), if used in excess, have a tendency to favour the development and growth of the potato disease; but potash manures applied in moderate quantities are most beneficial.

Radishes. — In order to obtain crisp, tender, mild-flavoured roots, it is of primary importance to obtain, by means of copious waterings with artificial manures, a rapid growth. It should always be borne in mind that a slow growth gives rise to tough, woody, hot roots, which are anything but palatable, even in salads. To obtain a rapid growth the following liquid manure should be frequently applied, especially in dry weather: Half an ounce of kainit, one ounce of sulphate of ammonia, two ounces of superphosphate, and half an ounce of iron sulphate to a gallon of water.

Rhubarb grows best in a rich, deep, somewhat moist soil. The roots are benefited by watering them with a solution containing two ounces of kainit, two ounces of superphosphate, and a quarter of an ounce of iron sulphate to a gallon of water. Rhubarb cannot well be supplied with too much manure if the ground is worked to a good depth. The above-mentioned liquid manure is a valuable addition to the ordinary mode of cultivating rhubarb.

Salsify likes a tolerably good soil, which should be prepared in the winter, and the manure put in twelve inches below the surface in order to prevent the roots from growing fangs. This soil will be ready for sowing in the following spring.

Scorzonera. — Although there is a great difference between the roots of this plant and those of salsify, the special manure recommended and the mode of cultivation is exactly the same. It should be borne in mind that the manures advised invigorate the plants, and create a healthy growth without over-stimulating.

Seakale should be grown in soils that have been deeply trenched and richly manured. Two pounds of guano to the square rod is a valuable addition to the ordinary manure used for the growth of seakale.

Tomato.—For outdoor crops apply one and a-half pounds of kainit, two and a-half pounds of sulphate of ammonia, half a pound of iron sulphate, and six pounds of superphosphate per

square rod a week or so before planting. Indoors crops are benefited by being watered with a solution containing one ounce of sulphate of ammonia, one ounce of iron sulphate, and one ounce of superphosphate to a gallon of water.

Turnips. — The soil should have previously received a moderate dressing of dung. Turnips are greatly benefited by using phosphatic manures; and the following special manure is thoroughly recommended for garden use: Two and a-half pounds of superphosphate, two pounds of guano, a quarter of a pound of sulphate of ammonia, and half a pound of kainit per square rod. The whole of the above ingredients should be applied as a mixture at the time of sowing the seed. After thinning, the young plants should be watered with a solution containing one ounce of iron sulphate to a gallon of water. Watering the young plants with the sulphate solution has proved most beneficial during the critical stages of early growth.

Vegetable Marrows require a plentiful supply of manure, and when grown in frames, or on mounds, ridges, or on the flat, they should be watered with the liquid manure recommended for the growth of cucumbers.

CHAPTER XIII.

Additional Formulae.

BY THE LATE MONS. DE VILLE.

IN addition to the formulæ given in Chapter XII., we also supply the following, contributed by an expert a few years ago to and published in "Amateur Gardening":—

Carnations.—One part of nitrate of lime or half a part of sulphate of ammonia, one part of nitrate of potash, and three parts of dissolved bones. Apply at the rate of one ounce to three gallons of water once a week to pot plants, two ounces per square yard in April and in June to border varieties.

Dahlias.—Peruvian guano. Two ounces per square yard once a fortnight; or two ounces per three gallons of water, giving this quantity to three plants, once a fortnight.

Roses.—Superphosphate, 12 lb.; kainit, 10 lb.; sulphate of magnesia, 2 lb.; sulphate of iron, 1 lb.; sulphate of lime,

8 lb. Mix thoroughly, and crush up fine. Apply in April at the rate of four ounces per square yard, and fork in.

Sweet Peas.—Four pounds of basic slag, if soil is heavy, or three pounds of bone-meal if light, and one pound of sulphate of potash. Apply above quantities to 30 yards run of row before sowing or planting. Later, when plants are in full growth, apply one part of nitrate of soda, four parts of dissolved bones, and one part of sulphate of potash, at the rate of one ounce per lineal yard of row once a fortnight.

Flower Borders.—One barrow-load of decayed manure, two pounds of basic slag if the soil is heavy, or two pounds of bone-meal if light, and half a pound of sulphate of potash per six square yards when trenching the soil before planting. For established borders apply one ounce of guano to three gallons of water. Apply this quantity to each plant once a fortnight in summer.

Lawns.—Three ounces of basic slag or four ounces of bone-meal, two ounces of kainit, and two ounces of sulphate of ammonia. Apply the slag, kainit, or bone-meal in above quantities per square yard in November; the ammonia in April.

Fruit.—One part of muriate of potash, one and a-half parts of sulphate of ammonia, and three parts of superphosphate. Apply at the rate of two ounces per square yard directly fruit has formed.

Beans and Peas. — Four pounds of basic slag, two pounds of kainit, one and a-half pounds of nitrate of soda. Apply the slag and kainit to 30 lineal yards of row, digging in before sowing. Apply the soda when the plants begin to flower.

Cabbages, Etc. — Three pounds of superphosphate, three pounds of kainit, one pound nitrate of soda. Apply the two first-named to each square rod of land before planting, and the nitrate of soda per square rod when the plants are established.

Potatoes.—One ton of decayed manure, 28 pounds of superphosphate, 28 pounds of kainit. Apply above quantities to every eight square rods of ground before planting.

Beet, Carrots, Parsnips, Etc. — Three pounds of basic slag, one pound of sulphate of potash, two pounds of nitrate of soda. Apply the two first-named to each square rod before sowing; and the nitrate of soda after the crops are thinned.

Onions. — Six barrow-loads of decayed manure, three pounds of kainit, five pounds of superphosphate, one pound of nitrate of soda per square rod. Apply the kainit and super-

phosphate and dung before sowing; the soda after thinning the crop.

Tomatoes.—One part nitrate of soda, one part Peruvian guano, one part kainit, one part superphosphate. Use one ounce to a gallon of water, and apply twice a week to plants bearing fruit only.

Tonks' Rose Fertiliser.—This is a favourite formula among expert rose growers. It consists of superphosphate of lime, 12 lbs.; sulphate of potash, 10 lbs.; sulphate of magnesia, 2 lbs.; sulphate of iron, 1 lb.; gypsum (sulphate of lime), 8 lbs. Mix thoroughly, crush up as fine as possible, after pruning. One application per annum, directly after pruning, is sufficient.

CHAPTER XIV.

Miscellaneous Manures.

Phosphate of Ammonia is a salt which contains a good supply of ammonia and soluble phosphates—in fact, it is all plant food. It is an excellent substance for choice fruit or flowering plants, applied at the rate of ½ oz. in a gallon of water once a week, when the plants require feeding.

Sal-ammoniac consists of a combination of ammonia and hydrochloric acid. It may be used as a source of nitrogen food, but should be applied only to bare pieces of land a fortnight before sowing or planting. Two ounces per square yard is the amount to use, and cabbage, lettuce, onions, leeks, and celery are the crops that will receive the most benefit from it.

Liquid Ammonia is another source of nitrogen. It must be used with caution. The best way to apply this substance is to put two tablespoonfuls in a gallon of water, and then use it only on the soil. Ammonia fumes will kill foliage.

Carbonate of Ammonia is a salt rich in nitrogen. It may take the place of nitrate of soda, or sulphate of ammonia, as a liquid fertiliser, but must never be used stronger than ½ oz. in a gallon of water.

Silicate of Potash is a salt containing soluble silica and potash. Soils contain plenty of soluble silica, but the potash in the substance will do good. Apply at the rate of 2 ozs. per square yard.

Charcoal is a substance sometimes used to prevent soils becoming waterlogged and sour. It is of a porous nature, and has a sweetening influence on soils.

Coal Ashes.—These may be used on very stiff clayey soils to keep them open, but should never be applied to sandy and chalky land. The quantity to use is two barrow-loads per square rod. The ashes made from anthracite are much better than those from ordinary house or steam coal.

Oyster Shells, when broken up into a fine condition, are useful in soils, for they supply lime in the form of carbonate, and will help to make sour soils sweet.

Rabbit and Dog Manure is not so good as farmyard dung. Best mixed with the compost heap, and afterwards applied to land used for the cabbage tribe.

Calcium Carbide.—When water is brought into contact with calcium carbide, a chemical change takes place, with the result that acetylene gas and a residue are formed. The residue consists chiefly of slaked lime, but a little carbonate and sulphate of lime may also be present. This substance may be applied to all soils requiring lime, at the rate of from 1 to 2 lbs. per square yard. It should only be used on vacant land.

Flue Dust. — This material varies greatly in its composition, and any value it might contain would depend upon the quantity of soot present in it. Being extremely fine in its composition, it would be a good thing to use in light, sandy, and chalky soils to make them more clay-like, and to give them greater retentive power for moisture. From two to five barrow-loads per square rod would be the amount to use.

Phosphate of Potash. — This concentrated plant food is a valuable one for feeding choice plants, for it consists entirely of potash and phosphoric acid in a form easily assimilated by the roots of plants. It should be applied at the rate of 1 oz. in 2 gallons of water once every fortnight to growing plants, but to give the best results some form of quickly available nitrogen should be used with it. (See Nitrate of Ammonia, page 47.)

Tanner's Bark.—The substance has no value in the garden for feeding purposes, but may be applied to soils of a stiff, clayey nature to make them more open and porous. The quantity to use would be from two to four barrow-loads per square rod, according to the nature of the soil. A thin covering may be also used as a mulch to conserve moisture.

Chemical Analysis of Typical Soils. — Taking the top foot of an acre of land as weighing 3,000,000 lbs., the

following amounts of plant food would be present in the types of soils named:—

	Light Sandy Soil. lbs.	Good Fertile Loam. lbs.	Heavy Clayey Soil. lbs.	Chalky Soil. lbs.	Peaty Soil. lbs.
Nitrogen... ...	3,600	6,300	4,500	3,700	12,000
Potash	4,500	7,350	9,000	2,700	4,500
Phosphoric Acid	2,350	3,700	2,150	5,200	4,300
Lime (combined)	17,400	20,000	5,2	The greater portion of the soil is chalk.	1,950
Chalk (carbonate of lime)	300	5,350	6 00 00		none.
Iron oxide ...	9,000	7,600	8,500	3,500	5,600
Magnesia ...	3,750	1,500	5,750	7,000	3,500
Sulphuric Acid ...	600	1,200	1,150	2,700	1,200

It will be seen by the above that the soil contains a vast store of food, but the greater part is locked up, and can only become available by tillage, and even then manures must be added if maximum results are to be obtained. Some of the soils shown above contain a large quantity of combined lime. This is principally in the form of silicates and sulphate of lime, and in that form is no use for keeping soils sweet. It is the chalk that supplies lime of the most useful kind.

Liquid Animal Manure.—This may consist of liquid urine collected from the stable or cow-house, or bedroom slops, or artificially made by suspending a peck of horse, cow, sheep, or poultry dung in a coarse sack in a 36-gallon tub or cask of water, and allowing it to soak for a week. Dilute the liquor with half or two-thirds water according to the nature of the crops it is to be applied to. Half and half would be a good strength for the average vegetable crops, or for roses or fruit trees. In the case of human urine add a few drops of sulphuric acid to the liquor when stored in the cask. To other liquid manures add four ounces of gypsum per gallon to fix the ammonia and keep the liquor free from objectionable smell.

Garden Refuse. — Such waste material as cabbage leaves, superfluous celery leaves, beet and parsnip foliage, potato peelings, shelled pea pods, turnip tops, tree leaves, lawn mowings, etc., should be placed in a heap, sprinkled with lime or gypsum from time to time, and occasionally turned over to decay, then be dug into the soil in autumn as a substitute for manure. Such a compost will be valuable for supplying humus as well as plant food to the soil. Cabbage stumps, diseased root crops, tree and hedge prunings, and potato haulm should be burnt, and the ash collected and stored in a dry place till spring, then be applied to the soil to supply potash.

Rape Dust.—This is a valuable substance for supplying nitrates to the soil, especially where the latter is deficient in humus. It contains, as a rule, about 5 per cent. of nitrogen and an infinitesimal percentage of phosphates and potash. Should be used during the growing season only at the rate of four to eight ounces per square yard at intervals of a month or so to such crops as leeks, onions, cabbage tribe, lettuce, endive, and onions. A bye-product obtained from the manufacture of oil, rape cake, etc.

Grass for Lawns.—To preserve a lawn in good condition, occasional dressings of artificial and farmyard manures are necessary. Without the addition of manures the various grasses degenerate, and rank weeds take their place. Grasses are benefited by the addition of phosphates, nitrate of soda, or sulphate of ammonia, and iron sulphate. The last-mentioned substance is also very useful for eradicating moss.

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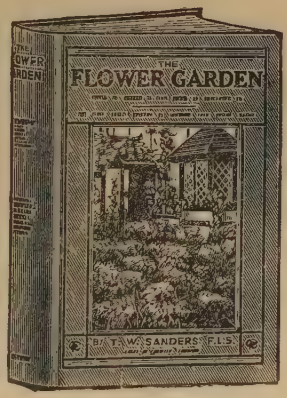

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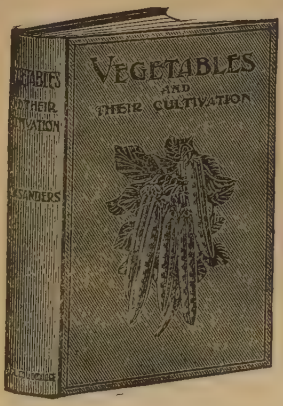

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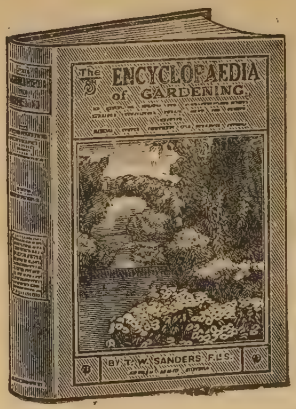

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